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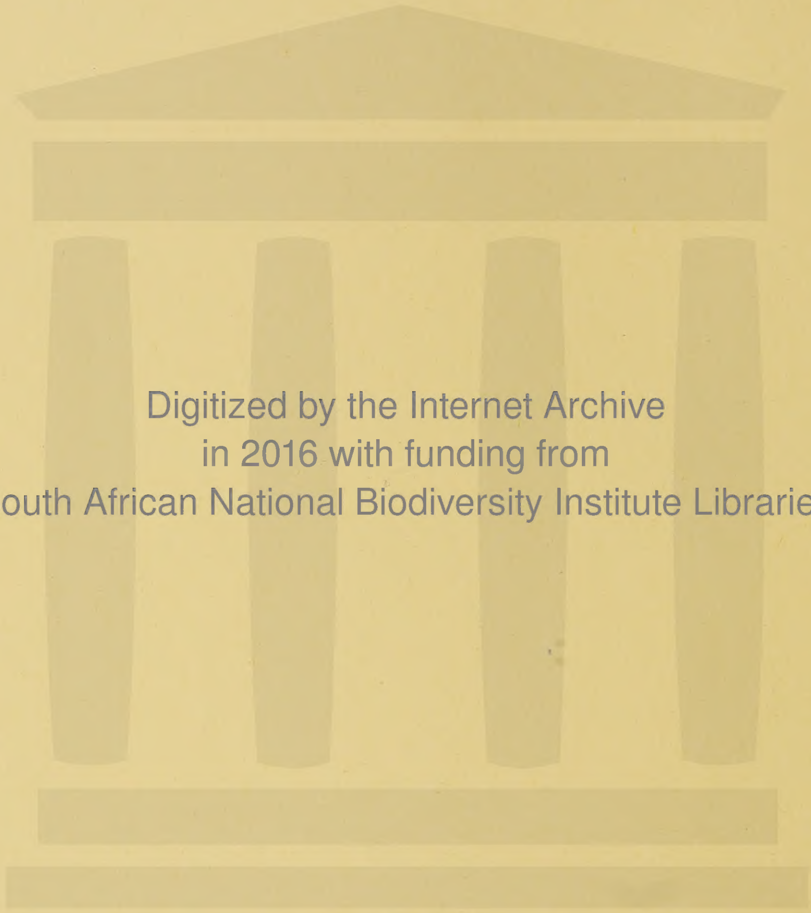

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VOL. XV.

DEVELOPMENT OF THE EMBRYOSAC OF *RESTIO DODII* AND *ELEGIA RACEMOSA*.

By Bessie Borwein, B.Sc. Hons. (Rand); Millicent L. Coetsee, B.Sc. Hons. (Rand); and S. Krupko, Ph.D. (Warsaw).

I. Introduction.

As far as the authors are aware these are the first studies on the megagametophyte of the Restionaceae. The Restionaceae is an interesting family of plants limited chiefly to South Africa and Australia. Only one representative of the family is found in South America and South Asia (Engler and Prantl) (1). In South Africa they are confined chiefly to the south-west region of the Cape Province where they are very abundant. Wettstein (11) regards the Cape Province as the probable place of origin of the family and it is certainly in the Cape that the largest variety of genera and species occur.

II. Methods.

The material was collected and fixed by Dr. S. Krupko in December, 1946 and January, 1947 in the Cape Peninsula. The ovaries were freed of their scales, cut at their bases and across the stigmas to ensure rapid penetration of the fixatives. Fixatives used were Stockholm's modification of Navashin, Fleming Strong and acetic Carnoy. Some material was pretreated with Carnoy for ten seconds before fixing in Navashin. Navashin gave the most satisfactory fixation. Much of the material was plasmolysed in spite of the use of a vacuum pump.

Dehydration was carried out by the Xylol method. Sections were cut on a rotary microtome at thicknesses varying from 8μ to 20μ, most often at 10μ. Two percent alc. Iron-haematoxylin and Newton's gentian-violet were the stains used. Brief staining in dilute Congo-red after alum differentation in the former case, showed up the cellulose walls of the nucellus, especially the chalaza, very clearly. Material fixed in Fleming was bleached in a mixture of half 50 per cent. alc. plus half H_2O_2 for 15 to 30 mins. Xylol balsam was used for mounting.

Eighty-eight ovaries of *Restio dodii* and 183 of *Elegia racemosa* were sectioned, this being the total number available to the authors in Johannesburg.

III. TERMINOLOGY.

Terminology used is that described and recommended by Maheshwari (1937) (2). For taxonomic descriptions of the South African Restionaceae the reader is referred to the works of N. S. Pillans of the Bolus Herbarium, Cape Town (5, 6, 7).

IV. OBSERVATIONS.

A. In both *Elegia racemosa* and *Restio dodii* the embryosac development was found to correspond to the normal type (Schnarf (9), Maheshwari (2, 3, 4).) The small differences between the two are dealt with in the following discussion.

B. **Elegia racemosa.**

Megasporogenesis. Nucellar differentiation was observed only in *Elegia racemosa.* The nucellar tissue appears as a small more or less oval area of cells at the base of the stigmas. These cells stain more darkly than the surrounding tissue and their cytoplasm appears denser. Only in the youngest buds where flower parts are not yet distinguishable is no nucellar tissue found. The area occupied by the cells of the nucellus varies according to the stage of differentiation. Where the bracts and stigmas are distinguishable, the nucellar tissue was found to be approximately 60μ long, 55μ wide and 42μ deep.

The megaspore mother-cell arises in the layer directly beneath the nucellar epidermis. The megaspore mother-cell is distinguishable from the surrounding cells by its increased size, large nucleus and less dense cytoplasm. (Fig. 1). The developmental stage of the ovule varies a good deal in the presence of the megaspore mother-cell. In some of the cases observed the integuments did not yet surround the nucellus whereas in other cases they did.

No stages showing division of the megaspore mother-cell into dyad cells were seen during the investigation.

A linear tetrad of megaspores was the next stage observed (Fig. 2) The chalazal megaspore enlarges while the other three degenerate (Fig. 3). The arrangement of nucleus and vacuole in the chalazal megaspore seems to be constant. The nucleus is towards the micropylar end and the vacuole is chalazal (Fig. 2). When this megaspore is greatly enlarged there are vacuoles on either side of the central nucleus, said by Maheshwari (1937) (2) to be typical of this stage (Fig. 4).

The division of the chalazal megaspore nucleus to form a 2-nucleate embryosac was not observed nor was a 2-nucleate embryosac seen.

The 4-nucleate embryosac shows the typical arrangement of 2 nuclei at each pole, separated by a large central vacuole. Arrangement of the nuclei, however, seems to be unusual in that the orientation of the chalazal pair of nuclei is in the longitudinal axis of the embryosac whereas the micropylar nuclei lie, as usual, in the horizontal axis (Fig. 5). The resulting T-shaped arrangement of the nuclei might be correlated with the distinct narrowing of the embryosac at the chalazal end.

No typical 8-nucleate embryosac with 4 chalazal and 4 micropylar nuclei, separated by a central vacuole, was observed.

The Mature Embryosac. The arrangement of the nuclei is typical (Fig. 7).

The Egg Apparatus is slightly lateral in position. The synergids are elongate cells. The egg-cell generally is not so elongate as the synergids and lies close to them, usually below one of them. In some cases it is difficult to distinguish the egg-cell from the synergids due to its proximity to them and some similarity in appearance.

Generally the arrangement of vacuoles and nuclei in the cells of the egg apparatus appears typical. The vacuole in the egg-cell is towards the micropylar end with the nucleus below it and this arrangement is reversed in the synergids (Figs. 8 and 9).

The Polar Nuclei are usually situated more or less centrally between the egg apparatus and the antipodal cells. The polar nuclei are the largest in the embryosac.

Antipodals : In the recently mature embryosac (Fig. 7) the 3 antipodals in the narrow chalazal end may be seen as rather angular cells with irregular nuclear masses. Older embryosacs frequently show more than 3 antipodals. The irregular nuclear masses of antipodals in Fig. 15 may thus be interpreted as mitotic division figures of the nuclei. Fig. 15 shows multiple antipodals arranged in pairs which indicates that cells persist closely allied for some time subsequent to division. Frequently bi-nucleate antipodals were found (Fig. 12). Bi-nucleate antipodals were seen in both a healthy and a degenerate condition. The multiple antipodals are difficult to count and seem to vary in number from 6 to 14. The antipodals seem to degenerate at various stages.

Elongation of the Embryosac : The mature embryosac elongates beyond the antipodals into the chalazal nucellar tissue, the antipodals remaining in position (Fig. 11). Narrowing at the chalazal end persists, the embryosac widening out above this level. Thus a bridge of nucellar tissue extends across the embryosac at the original chalazal end. In some cases, the antipodals, in being left behind, become lateral to the embryosac.

The only Indications of Fertilization were seen in some of the most mature ovules investigated. These ovules show great increase in size (Fig. 13), the outer integument and outer layer of the inner integument are squashed. At the chalazal end of the ovule a cap of tannin-filled cells has developed. In some cases (Fig. 14) the micropyle is filled with pollentube remains, which are visible also within the embryosac. No male nuclei were seen. Frequently the darkly stained egg apparatus and remains of pollentube could not be sufficiently differentiated to make accurate observation possible.

C. **Restio dodii.**

Megasporogenesis was not observed since no material from very young buds was available.

The earliest stage observed was that of an enlarged chalazal megaspore with 3 degenerated megaspores (Fig. 16). From the position of these degenerated megaspores it is inferred that a sub-epidermal cell differentiated to become the megaspore mother-cell and that the result of meiosis was a usual linear tetrad of megaspores. At this stage the 2 integuments are not yet closed, but in all stages after this the integuments had closed. The enlarged megaspore shown in Fig. 16 is 19μ long and 10μ wide and its nucleus has 2 nucleoli.

Neither the division of the enlarged megaspore nor the 2-nucleate stage was observed.

A 3-nucleate stage of the embryosac (Fig. 17) was seen with a large vacuole separating the 2 mincropylar nuclei from the one chalazal nucleus. A 3-nucleate stage can be reached only by a non-synchronous division of the first two embryosac nuclei. Departures in the sequence of these divisions are usually in the nature of abnormalities that may occur now and then in any plant and have no special significance. Delayed division commonly occurs in the lowest part of the embryosac. (Maheshwari (1937) (2).)

Four-nucleate embryosacs (Fig. 18) were seen and it is probable that synchronous divisions are the rule, especially as spindle-fibres at each end of the embryosac were observed in one section. These 4 nuclei divide, as usual, to form the usual 8-nucleate embryosac (Fig. 19). An 8-celled stage was observed in which the nuclei are clearly separated by cell walls. This 8-celled stage was observed only once and may be regarded as a peculiar feature since we did not find references to any such 8-celled embryosac in the literature reviewed (Fig. 20).

The Mature Embryosac : The mature embryosac consists of an egg-cell, 2 synergid cells, 2 polar nuclei and always 3 or more antipodal cells, almost always uni-nucleate.

The Egg Apparatus : The egg and synergids are large and well developed, their nuclei being of approximately equal size. The egg is a spherical body lying between the 2 synergids (Fig. 24*b*) usually more to one side than the other (Fig. 24*b*). Often the egg lies over one of the synergids and seems to obliterate it (Fig. 25).

There was a marked difference in staining between the nucleus of the egg, synergids, polars and antipodals. Often the egg nucleus was completely decolorised, when the other nuclei were stained clearly. The synergid cells are slightly elongated, tapering towards the micropyle. Most often, one synergid was seen to be degenerating, while the other was still in a healthy condition (Fig. 24*c*). In many cases where there were no indications that fertilization had occurred (there were no pollen-tubes or pollentube remains and no male nuclei present) one synergid cell was seen to be degenerating, no nucleus was present, the cytoplasm was quite black in patches and the rest was coarsely granular and dark staining (Fig. 24*a*). Occasionally both synergids appeared to be degenerating with no nuclei present, before fertilization seemed to have occurred (Fig. 30). It seems that one synergid and occasionally both, begin to disorganize before fertilization. Similar phenomena have been reported by Regan (8) in *Agave virginica* where the synergids may occasionally disorganize before fertilization and by Murphy (4) in *Allium cernuum* where one synergid regularly disintegrates before fertilization.

Polar Nuclei are by far the largest of any in the embryosac. They may lie adjacent to the egg apparatus (Fig. 26) or some distance away (Fig. 25) but never in the centre of the embryosac. Fusion of the polar nuclei seems to be long delayed, since even in the stage of the fertilized egg nucleus, 2 adjacent polar nuclei are still present (Fig. 25). The nuclei were almost always seen close together, as if about to fuse (Fig. 26). Rarely was one nucleus found in the region of the polar nuclei. Since such a nucleus was found only where the egg was in division and no male nuclei were present, it was assumed to be the endosperm mother-cell (Fig. 31).

Antipodals : The first three antipodals divide irregularly, a number of times. Any number of antipodals, from 9 to 15, and possibly more, were observed, but the exact number could not be determined where many were present. Fig. 27*ab* shows about 11 nuclei. Fig. 29*f* about 14.

Most of the embryosacs studied showed more than 7 antipodals. The cells begin to degenerate just before or just after fertilization. The antipodals all apparently degenerate but the time of the onset of disorganisation shows no particular correlation with the stage of development or fertilization of the embryosac. (Fig. 23 *a b c*) are antipodals from a fertilized embryosac, (Fig. 27) from a mature unfertilized embryosac. The antipodal nuclei are slightly smaller than those of the egg apparatus.

Fertilization : All indications of fertilization were observed. Often pollen tube remains in the micropyle and pollen tubes in the ovary tissue, were observed (Fig. 35). Bodies that were almost certainly male nuclei were seen in several embryosacs (Figs. 25, 26, 33). Fig. 26 shows an egg nucleus in division, probably early metaphase and a male nucleus near the polar nuclei. The male nuclei are considerably smaller than those of the female. It seems that the egg is fertilized before triple fusion occurs (Fig. 26) and that the egg divides before the primary endosperm nucleus divides.

D. The ovules of the Restionaceae are pendulous (Pillans (5).) It was observed in *Elegia racemosa* and *Restio dodii* that the micropylar end of the embryosac faces not towards the stigma but towards the ovary stalk (Fig. 22). Thus the pollentube must grow down the side of the ovule and around the integuments at the micropylar end to reach the embryosac through the micropyle.

E. *Increase in Size of the Embryosac.*

In the early stages of development, the embryosac occupies less than half of the nucellus and is found only in the micropylar end of the ovule. When mature, the embryosac fills almost the entire ovule, except in the chalazal region, where the embryosac never extends to the region from which the integuments arise.

In the micropylar region, the nucellar tissue covering the embryosac is only one cell thick and occasionally two cells. The most marked and most rapid increase in size, particularly the length, in *Restio dodii*, takes place from the 8-nucleate stage to the mature embryosac.

The mature embryosac of *Restio dodii* varies from 275μ to 350μ in length.

F. *The Integuments and Tannin Deposition.*

The 2 integuments are each two cells thick, except over the micropyle, where they may be several cells thick, especially the outer integument. In *Restio dodii*, tannin appears in the inner layer of the inner integument after the primary 8-nucleate stage. This layer is continuous in both *Restio dodii* and *Elegia racemosa*, except in a small region over the micropyle, where there is no tannin at all. In late maturation stages the region of tannin in the chalaza tends to become larger and an area of tannin-filled cells is found at the base of the chalaza (Fig. 22). In all stages tannin is present in the ovule epidermis.

G. *Failure of Embryosac Formation.*

A few ovules were found in which no megaspore mother-cell or any product of its divisions were found. Fig. 34 illustrates such an ovule. It will be seen that the integuments are completely closed—a stage in which an embryosac should have been formed—and that tannin has appeared in the inner layer of the inner integument and occasionally in the outer layer of that integument. The centre of the ovular tissue shows a small area of tannin-filled or degenerate cells.

Ovules were found with relatively large embryosacs devoid of contents or with blackened and degenerate contents. Increased tannin development was frequently observed in the region of insect bites.

The occasional failure of the formation of reproductive cells has been noted by other workers. Among others, Regan (8) in Agave found many of the ovules formed no reproductive cells at all and were sterile and abortive.

V. DISCUSSION.

The normal course of development has been found in the vast majority of Angiosperms investigated thus far (Maheshwari, Schnarf and Wettstein). There are deviations within the normal course of development which occur chiefly in tetrad formation, divisions of the megaspore nucleus and organization of the embryosac (Maheshwari, Schnarf and Wettstein). In *Elegia racemosa* and *Restio dodii* minor deviations are seen in the behaviour of the antipodals and in the extensive elongation of the embryosac in the former.

Schnarf (1929) (10) emphasizes the fact that the antipodals are the most variable constituent of the embryosac, in number, form of cell and nucleus and in persistence. He considers that antipodals play a significant nutritive role in species in which this tissue is well developed. In *Restio dodii* the antipodals are always numerous and appear to persist into fertilization stages. These facts seem to indicate that the antipodals contribute in one manner or another to nutrition of the embryosac and the embryo.

Antipodals in *Elegia racemosa* multiply at random to form, in some cases, a fairly prominent tissue. In other cases, however, degeneration of the antipodals occurs before endosperm formation is initiated. Thus the possible nutrient value of the antipodals in this case needs further investigation.

A large number of workers report that the grass embryosacs usually contain numerous antipodal cells (Stover 11). The large number of antipodals found in *Elegia racemosa* and *Restio dodii* may indicate some alliance between the Gramineae and the Restionaceae embryosacs.

The elongation of the embryosac in *Elegia racemosa* would tend to strengthen this alliance. Elongation of the embryosac above the antipodals into the chalazal nucellar tissue is described by Stover (11) as a typical feature of some Gramineae members. Elongation is extensive, the embryosac becoming as much as twice its original length, as was also found to be the case in *Elegia racemosa*. Almost complete absorption of nucellar tissue noted by Stover was not observed in *Elegia racemosa*. Antipodals also do not become typically lateral in position to the embryosac as is quoted for grasses, though in some cases lateral disposition was observed.

Elongation of the embryosac has been observed also in several members of the Centrospermales, by Maheshwari (2). The embryosac elongates at the chalazal end, absorbing its way through the nucellus and pushing forward while the antipodal cells remain *in situ* and are relegated to a lateral position. This elongation which has been found in a certain number of plants seems to be a very effective haustorial organ.

Tannin in the ovary wall and its development within the inner layer of the inner integument, is a conspicuous feature in ovule development in both *Elegia racemosa* and *Restio dodii*. Thatcher (12) thinks that tannins probably do not serve in any significant way as food materials. They are usually elaborated when intense metabolism is taking place or in rapid tissue formation. Tannins may also act as protective agents, as for example against parasite fungi.

They have also been associated with lignin formation, lignification occurring in those cells where tannin was earlier deposited. This would seem to be the case in the *Restio dodii* fruit which is enclosed in a tough hard covering. In *Elegia racemosa* it was found to be most difficult to section old ovaries because of their hardness due to tannin deposition and subsequent lignification.

VI. CONCLUSION.

The development of the embryosac in both *Restio dodii* and *Elegia racemosa* corresponds to the normal type, its egg-cell being removed from the megaspore mother-cell by 5 divisions, and only one megaspore taking part in the embryosac formation. The total number of nuclei in the mature embryosac is greater than the usual eight, due to the presence of more than 3 antipodal cells. The antipodals multiply vegetatively, resulting in a condition which has no special significance in the classification of embryosac types. The antipodals may however, be of importance in nutrition of the embryosac, in view of their occasional persistence in an apparently healthy condition late in embryosac development. This deviation which occurs in antipodal behaviour in both plants, and elongation of the embryosac in *Elegia racemosa*, may serve, however, to strengthen an association between Restionaceae and Gramineae.

VII. SUMMARY.

Embryosac formation in both *Restio dodii* and *Elegia racemosa* was found to follow the normal course of development.

In *Elegia racemosa* the following stages were observed :—

1. Differentiation of megaspore mother-cell.
2. Linear tetrad of megaspores.
3. Enlarged chalazal megaspore.

The 4-nucleate stage was noted in both plants, while the 8-nucleate stage was observed in *Restio dodii* only. The mature embryosac shows the normal arrangement of egg-cell, synergids and polar nuclei.

Antipodals are numerous in both cases, appearing to multiply vegetatively. In *Restio dodii*, in one case only, an 8-celled embryosac was observed. Elongation of the embryosac was seen to occur in *Elegia racemosa*. Fertilization was observed in *Restio dodii*, where the polar nuclei are not fused even after fertilization.

Tannin development in the ovary wall and in the inner layer of the inner integument is marked in both plants.

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EXPLANATION OF PLATES.

Figs. 1—15 *Elegia racemosa*. *Figs.* 16—35 *Restio dodii*.

All drawings were made with a Zeiss camera lucida. For drawings of *Elegia* *racemosa* a Bausch and Lomb microscope with the following lenses was used :—Obj. 10 ×, 43 ×, 97 × ; oc. 10 ×.

Drawings of *Restio dodii* were made using a Leitz microscope with obj. 3 ×, 7 ×, 1/12 (oil immersion) and a 4 × oc. The Bausch and Lomb condensor had an n.a. of 1.25, the Leitz of 1.3.

Figs. 1, 2, 3, 4, 6 .. 150 × ; Figs. 7, 13 .. 800 × ; Figs. 5, 8, 9, 10, 11, 12, 15 .. 1,700 × ; Figs. 16, 17, 18, 19, 20, 23, 24, 25, 26, 27, 28, 29, 30 .. 1,600 × ; Figs. 21 .. 1,300 × ; Fig. 22 .. 140 × ; Figs. 34, 35 .. 600 ×.

Abbreviations :—

ac.	antipodal cell.	m.	micropyle.
an.	antipodal nucleus.	mn.	male nucleus.
cc.	chalazal end.	n.	nucellus.
c.m.	chalazal megaspore.	o.	ovary tissue.
c.n.	chalazal nucleus.	o.i.	outer integument.
e.	egg.	p.n.	polar nucleus.
e.s.	embryosac.	pt.	pollen tube remains.
e.es.	elongation of embryosac.	s.	synergid.
i.i.	inner integument.	t.i.	tannin of inner integument.

Fig. 1. Megaspore mother-cell directly beneath nucellar epidermis.
Fig. 2. Tetrad of megaspores.
Figs. 3 and 4. Enlarged chalazal megaspores.
Fig. 5. Four-nucleate embryosac.
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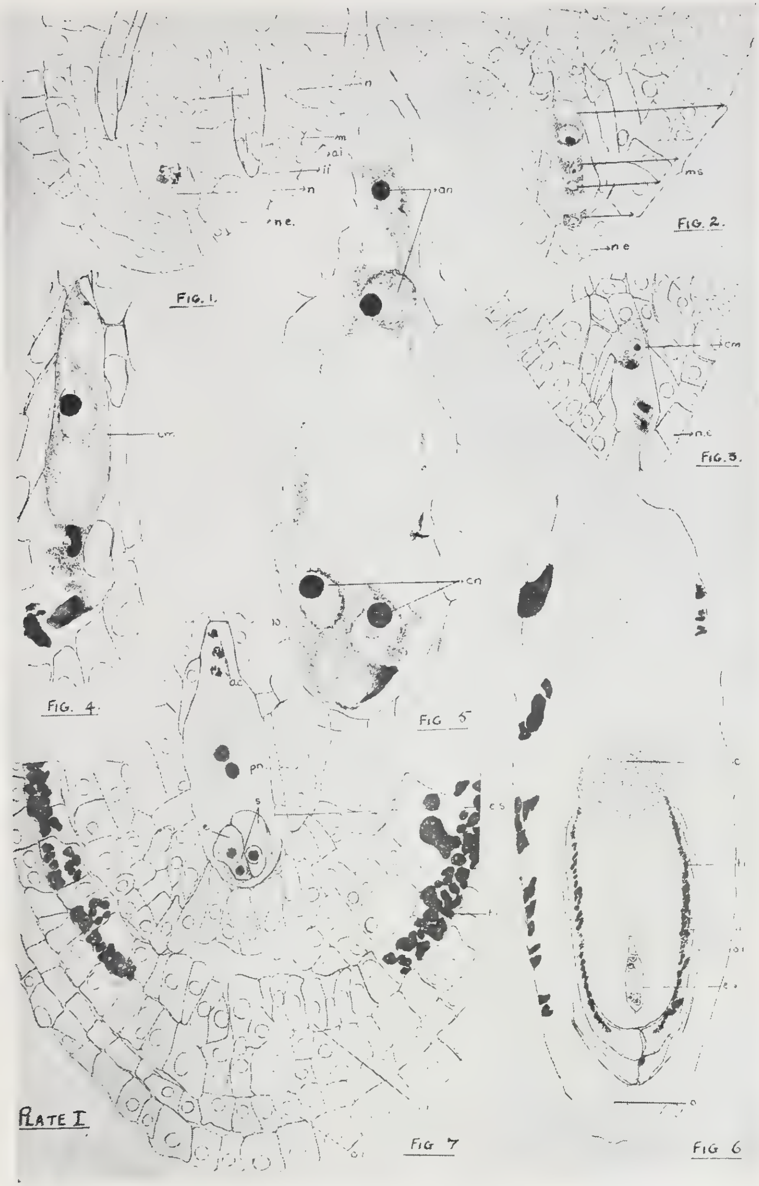


Plate I. Restionaceae.

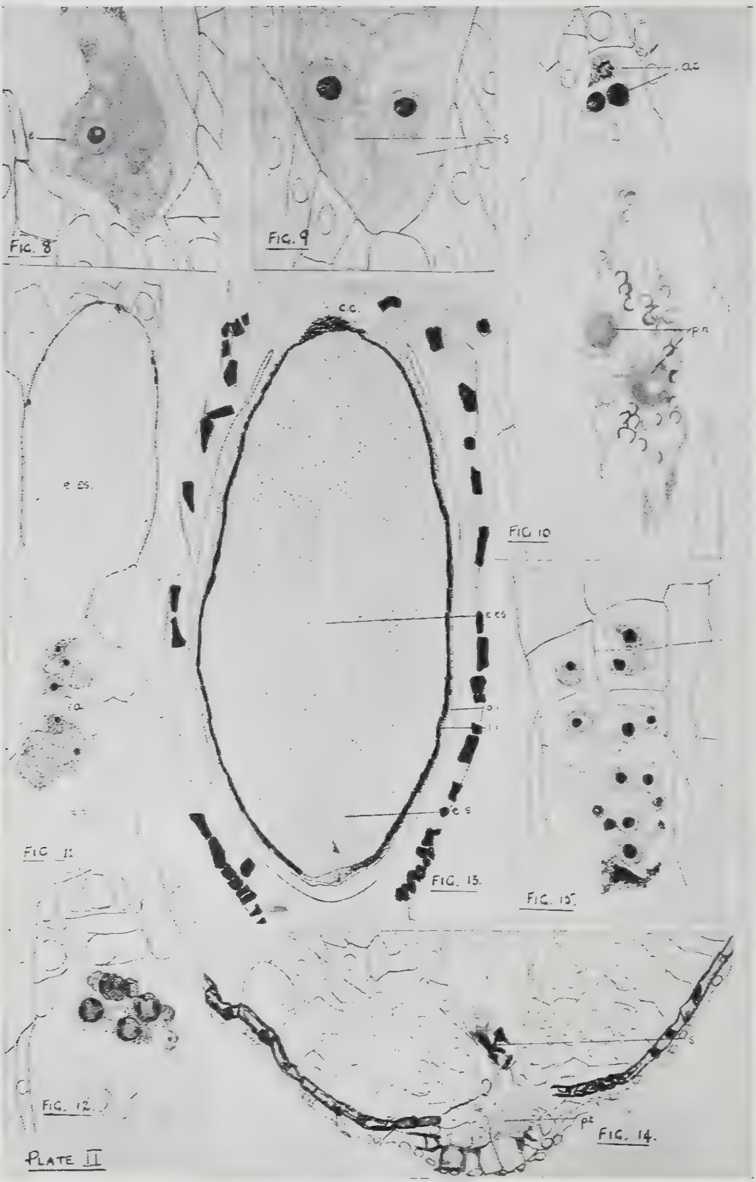


Plate II. Restionaceae

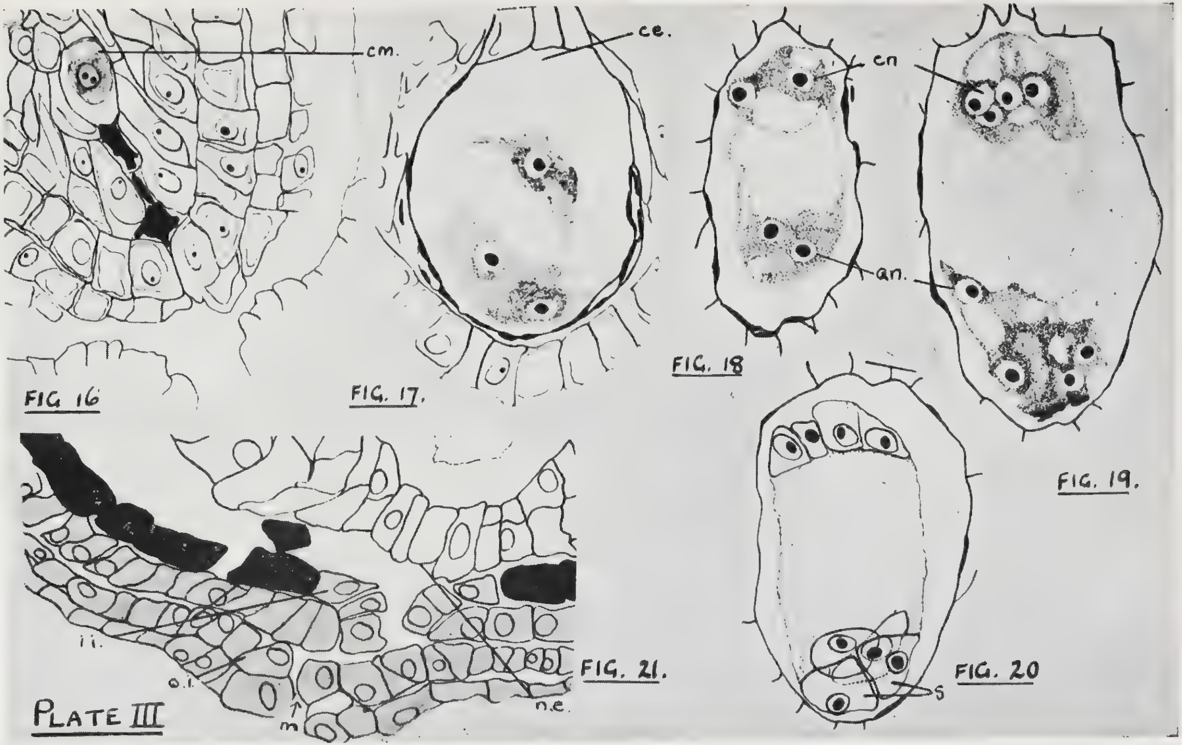


PLATE III. Restionaceae.

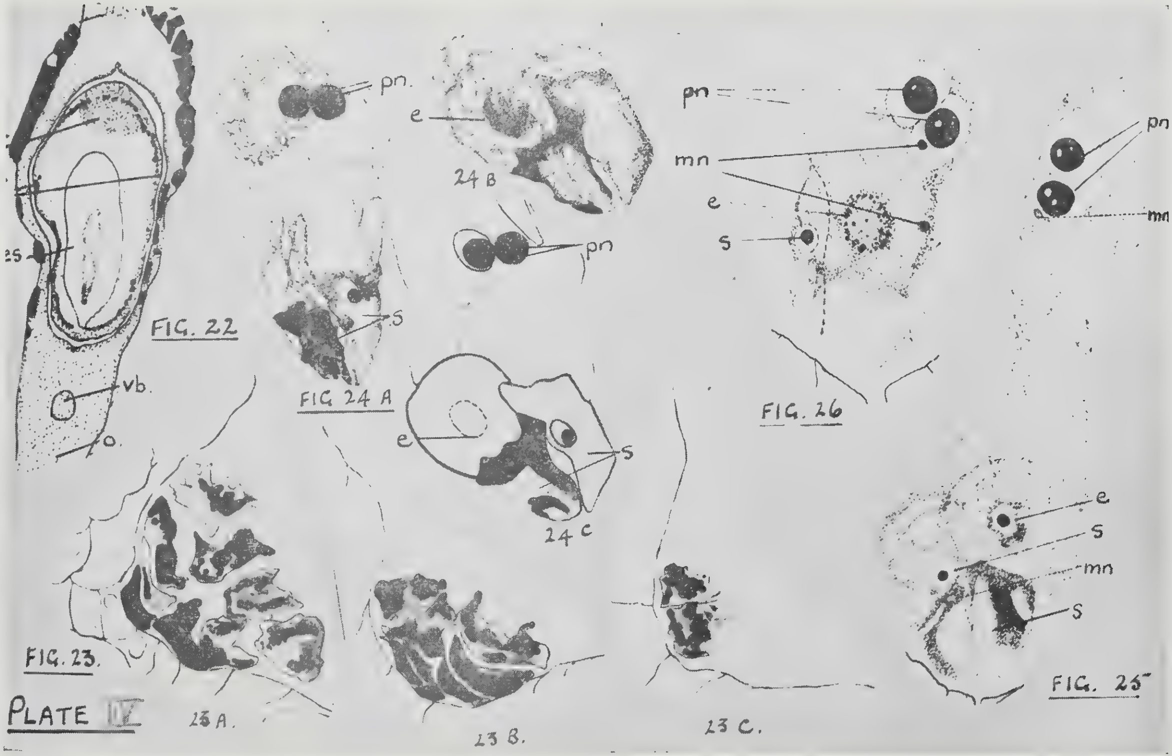


Plate IV. Restionaceae.

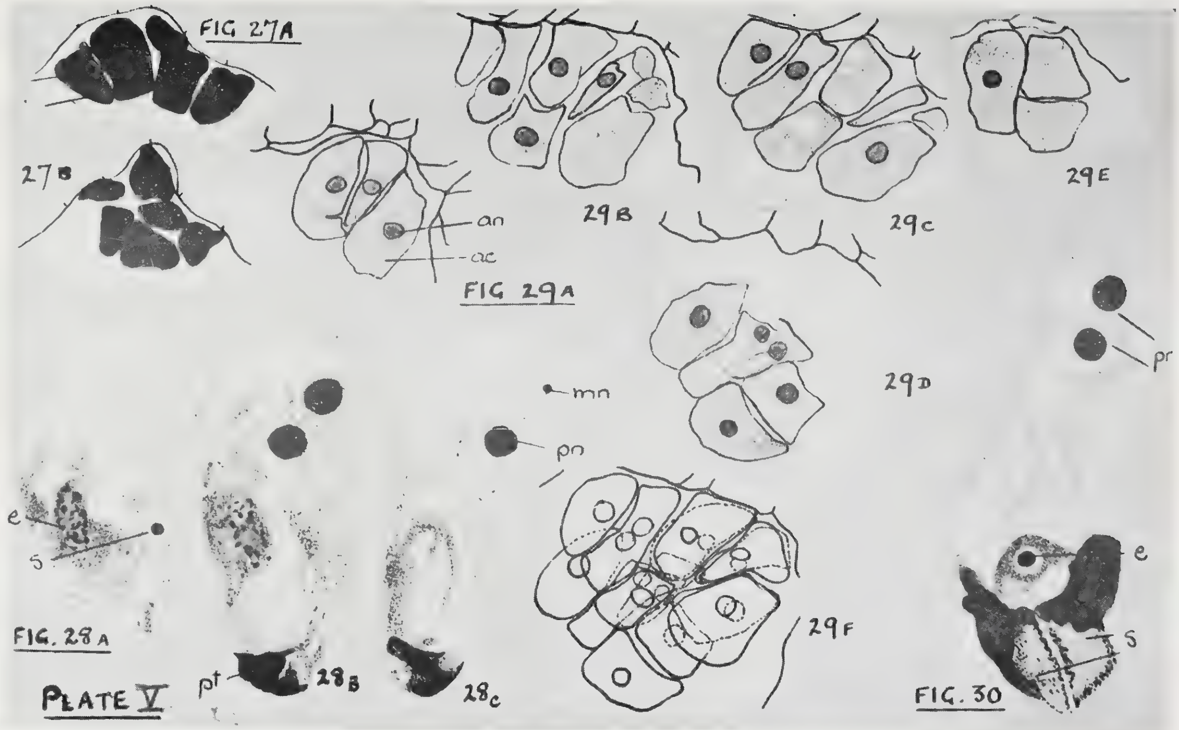


Plate V. Restionaceae

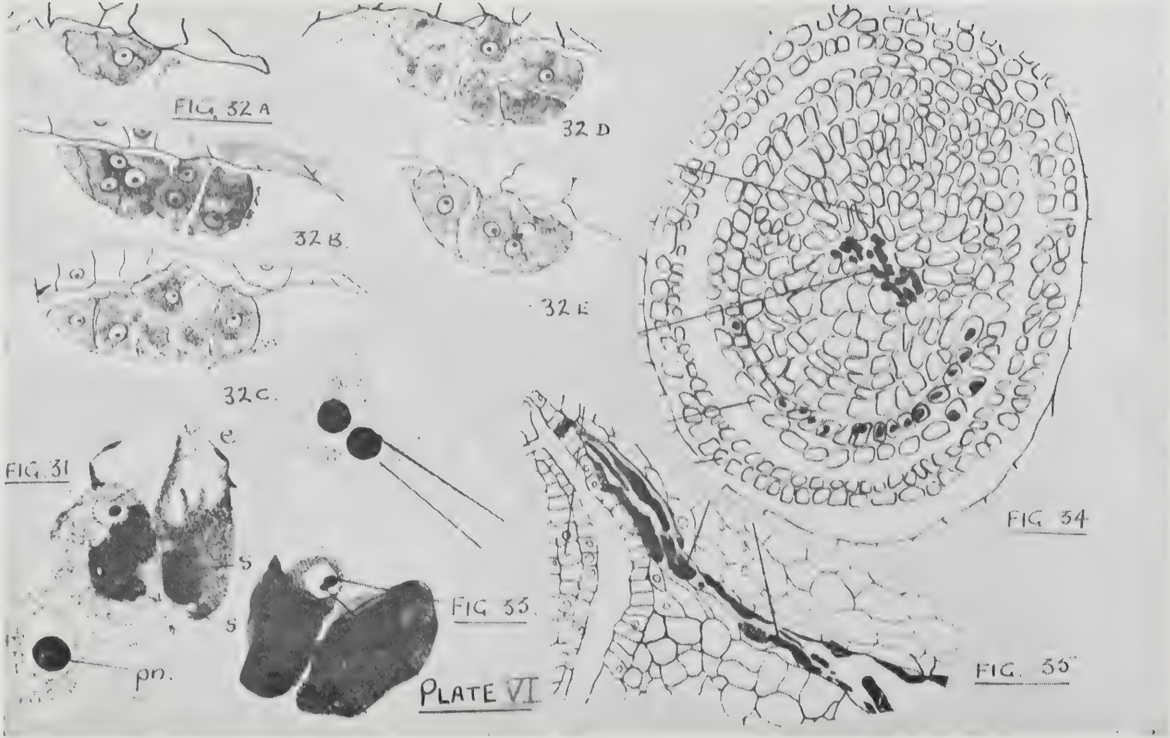


Plate VI. Restionaceae.

THE DEVELOPMENT OF THE OVULE AND THE SEED IN THE HYPOXIDEAE.

PART II.

THE GENERA *PAURIDIA HARV.* AND *FORBESIA ECKLON.*

BY MIRIAM P. DE VOS., D.SC.

Since the systematic position of the monotypic genus Pauridia still seems to be rather uncertain, the development of the ovule and the seed of *P. minuta* was investigated to determine whether this would throw any new light on the position of the genus. *P. minuta* resembles members of the genus Ianthe, especially *I. minuta*, but has only three stamens. Bentham and Hooker tentatively placed the genus under the Hypoxideae ; Hutchinson, however, places it in the Hypoxidaceae, but Pax (Engler and Prantl) considers it to belong to the Haemodoraceae.

Pauridia minuta (L.f.) Dur. et Schinz.

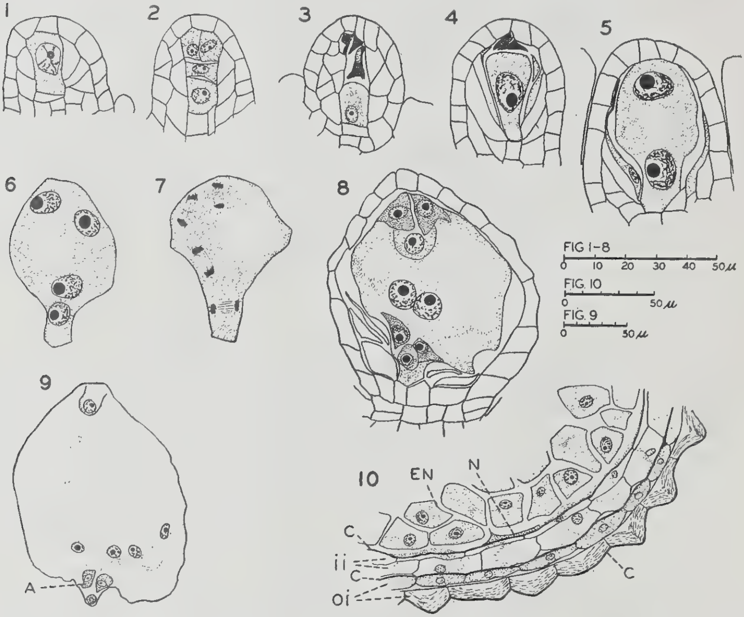
As in the genus Ianthe, the ovary is trilocular with axile placentation. Markötter (1936) considered the ovules to be anatropous. Usually, however, the raphe is short and does not reach the region of the micropyle. Such ovules should rather be called hemitropous. In a few cases the raphe is longer and the ovule therefore truly anatropous.

Gametogenesis. The archesporial cell, which is hypodermal in origin, functions directly as a megaspore mother-cell and enlarges considerably before the reduction division. After the first reduction division a cell-wall is laid down between the two daughter nuclei, and after the second division four megaspores are formed, usually in a T-shaped arrangement, but in a few cases in linear position.

While the three upper megaspores degenerate and disappear, the chalazal one enlarges and divides three times to form a normal 8-nucleate embryo-sac. The nucellus is small and consists of a number of cells at the chalaza and an epidermis covering the embryo-sac. Both integuments take part in the formation of the micropylar canal, and each consists of only two layers of cells.

The mature embryo-sac which has a narrow base and wide upper part, contains the egg-cell and two synergids, three antipodal cells and the secondary nucleus, formed by the fusion of the two polar nuclei. The sac has a large vacuole and some peripheral cytoplasm in which starch grains are embedded. Starch is also present in the synergids and the antipodal cells but not in the egg.

Abnormalities frequently appear in some ovaries, *e.g.* the nucellus, containing a mature embryo-sac, may protrude from integuments too short to cover it ; or the nucellus may be covered only by the outer integument, the inner one remaining short; or embryo-sacs of some ovules may be late in developing. After fertilization many ovules degenerate and this is probably due to the non-occurrence of fertilization.



Figs. 1—10. *Pauridia minuta*, development of the embryo-sac and endosperm. 1. Hypodermal megaspore mother-cell. 2. Four megaspores. 3. Functioning megaspore, the others degenerating. 4. Chalazal megaspore enlarging. 5—7. Further development of the embryo-sac. 8. Young mature embryo-sac. 9. Early development of the endosperm. 10. Section through nearly ripe testa with a small part of the endosperm. A. Antipodals. C. Cuticle. EN. Endosperm. II. Inner Integument. N. Remains of Nucellus. OI. Outer integument. Figs. 1—8 × 480 ; 9 × 200 ; 10 × 280.

The Endosperm. After the fertilization the embryo-sac enlarges considerably at the expense of some of the basal nucellar cells. By repeated nuclear divisions the primary endosperm nucleus produces a large number of nuclei embedded in a layer of cytoplasm along the periphery of the embryo-sac. Helobial development of the endosperm does not take place and no basal endosperm chamber is formed.

The antipodal cells persist for some time after the fertilization and in some cases one of them enlarges, eventually becoming binucleate.

Cell-walls are laid down between the endosperm nuclei after about 130 to 150 have been formed,when the young embryo is in the quadrant or the octant stage. At this stage the antipodal cells have nearly disappeared, their degeneration starting when the fertilized egg-cell begins to divide. By repeated cell divisions the endosperm later fills the embryo-sac completely with a thin-walled tissue containing large amounts of food reserves, found by Markötter to consist of protein and oil.

The Embryo. After a short resting stage the fertilized egg-cell, attached to the wall of the embryo-sac near the micropyle, begins to divide. The first division is transverse, thereby forming an apical and a basal cell, *ca* and *cb*. The following divisions take place in both cells : in the basal cell by a transverse wall, forming the cells *m* and *ci*, and in the apical cell by a longitudinal wall.

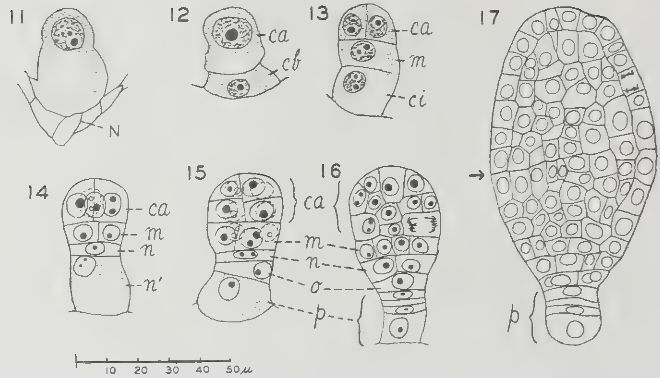
The octant stage is reached after another division in each of the four cells : in *ci* by a transverse wall forming the cells *n* and *n'*, and in *m* and in the two apical cells by longitudinal walls. Thus the original apical and basal cell each contribute four cells to the eight-celled embryo. In the next stage each cell divides again : the four upper cells divide by transverse walls so that two four-celled tiers are formed, the two middle cells by longitudinal walls at right angles to the first thus producing four cells, the cell *n* by a longitudinal wall, and *n'* by a transverse wall forming *o* and *p*.

After this 16-celled stage the divisions become increasingly irregular. The cells produced from the original apical cell form only the upper part of the embryo, *i.e.* the apical cotyledon. Cells produced from the layers *m*, *n*, and probably from *o*, all of which are derived from the basal cell *cb*, form the lower part of the embryo, *i.e.*, the radicle and hypocotyl, The cell *p* forms a short suspensor after undergoing a few further transverse divisions.

The embryo in the ripe seed is undifferentiated except for the dermatogen and a small dent on one side which shows the position of the growing point of the future plumule.

In Pauridia the development of the embryo is therefore identical with that of *Ianthe aquatica*. Both the original apical and basal cell contribute in large measure to the structure of the embryo, the development of which therefore conforms to the Asterad type (Johansen 1945).

The Testa of the seed is formed by both the integuments, each of which remains two-layered. The epidermal cells of the outer integument form rounded protuberances to the outside, but not as large as those in *Ianthe minuta*. The cavities of these cells become filled with cellulose



FIGS. 11—17. *Pauridia minuta,* development of the embryo. 11. Fertilized zygote. 12. Two-celled pro-embryo. 13. Quadrant stage. 14. Octant stage. 15. Embryo having nearly reached the sixteen-celled stage, cell *n* still having to divide longitudinally. 16. Beginning of the differentiation of the dermatogen. 17. Undifferentiated embryo of the nearly ripe seed. The arrow indicates the probable division between the original apical and basal cell. *ca,* apical cell ; *cb,* basal cell ; *m,* middle cell ; N, nucellus ; *p,* suspensor ; *m, n, o* and *p* develop from the original basal cell. × 480.

laid down layer by layer within the outer cell-wall. Later this cellulose turns brown and eventually black due to the deposition of some other substance. The second cell layer of the outer integument is narrow, the cells retaining their protoplasmic contents until the seed is nearly ripe.

The outer layer of the inner integument consists of large thin-walled cells with very little protoplasm. They are, however, smaller than in the Ianthe species investigated and later they are compressed by pressure from the developing endosperm. The cells in the second layer are flat and contain a little protoplasm until a late stage.

Three narrow cuticular layers are present : the first on the outer surface of the seed-coat, the second between the two integuments, and the third between the nucellus and the inner integument. In the micropylar region the inner cuticle is folded as in species of Ianthe.

The nucellus at the top and along the sides of the embryo-sac is gradually absorbed, but at the base remnants of it are still visible in the nearly ripe seed.

Forbesia plicata (Ait.) Nel.

As described by Markötter, the ovary has one chamber containing a number of ovules with long bent funicles, arranged in parietal placentation. They are hemitropous and at the same time slightly campylotropous, but not anatropous as stated by Markötter.

Gametogenesis. The hypodermal archesporial cell functions directly as megaspore mother-cell and undergoes meiosis. After the first reduction division a cross wall is laid down between the two interphasic nuclei. The second reduction division in the upper cell is incomplete, the cell contents degenerating before, during, or just after this division. The nucleus in the basal cell divides for the second meiotic division, but as no wall is laid down, this cell becomes binucleate. The nuclei are at first in close proximity and then move apart, a vacuole developing between them. They enlarge and undergo two further divisions to form the eight nuclei of the embryo-sac. The embryo-sac is therefore formed from two megasporic nuclei after two further mitoses.

When the flower opens the sac contains an egg-cell and two synergids, three very small antipodal cells and a definite nucleus formed by the fusion of the two polar nuclei.

Before the reduction division the nucellar epidermis above the megaspore mother-cell divides and becomes two-layered, and while the embryo-sac develops these cells divide several times more, thus forming a large nucellar cap above the egg apparatus. On the sides the embryo-sac absorbs some of the nucellar cells, so that for a short distance the sac is covered only by the nucellar epidermis. The lower half of the embryo-sac, however, is embedded within a massive nucellar tissue, some of whose cell-walls in the immediate vicinity of the base of the sac show the presence of lignin.

The Endosperm. After the first division of the primary endosperm nucleus a cell-wall is laid down, cutting off one of the two nuclei in the basal end of the embryo-sac. This nucleus divides several times and at the same time the amount of cytoplasm in this basal chamber increases considerably. The nuclei increase in size and become hypertrophied, and the basal chamber forms a short protuberance into the nucellar tissue and probably functions as a chalazal haustorium. It does not however, touch the vascular strand which ends in the chalaza.

In the large upper chamber the endosperm proper develops. The nucleus divides repeatedly and forms a number of nuclei embedded in a layer of cytoplasm. Later cell-walls are laid down, thus forming a layer of cells, and by repeated cell divisions the embryo-sac becomes filled with endosperm tissue.

The antipodal cells are small and degenerate soon after the fertilization, their place being taken by the basal endosperm chamber.

The Embryo. The development of the embryo was observed only as far as the quadrant stage. The first division is transverse, and in the next divisions a longitudinal wall is formed in the apical cell and a transverse one in the basal cell, thus making the quadrant stage identical with

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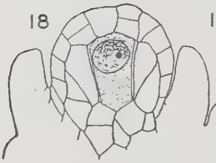

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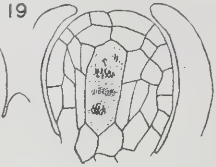

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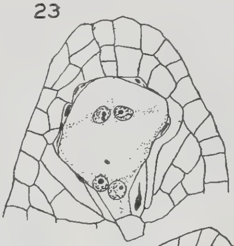

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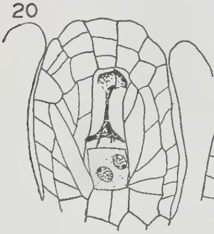

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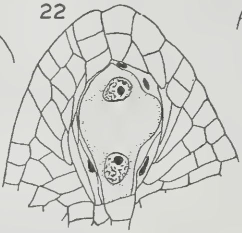

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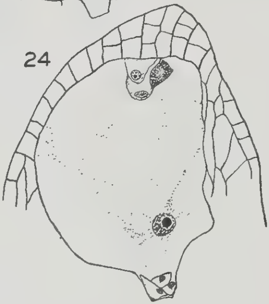

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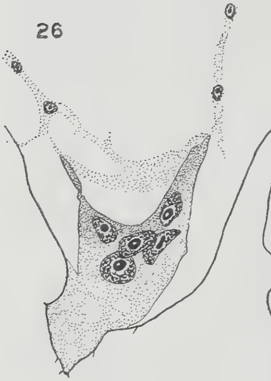

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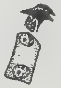

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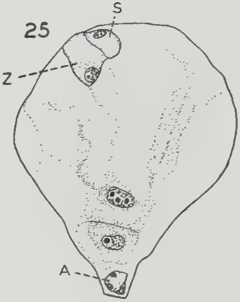

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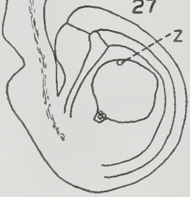

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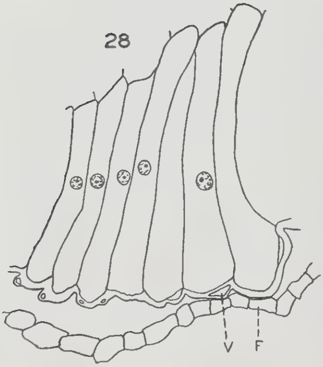

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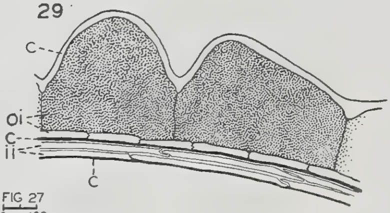

FIG 27
0 100

FIG. 24-26, 28, 29
0 50

FIG. 18-23
0 50

that of species of Ianthe and Pauridia. The following stages are probably similar to those in the above-mentioned plants. As in Pauridia and Ianthe, the embryo in the mature seed is undifferentiated.

The Testa. The integuments consist of two layers of cells except at their tips where they are thicker. The inner integument remains two-layered, the cells increase slightly in size and become very poor in protoplasmic contents. Later these cells are squashed and the cell walls are converted into an orange-coloured membrane which becomes either suberised or cutinised.

In the outer integument some of the cells of the inner layer divide by periclinal walls, making this integument subsequently for some part three-layered. The cells of the inner layer are small and possess large amounts of protoplasm which persist with their nuclei until the seed is nearly ripe, and some starch. The cells of the epidermal layer form protuberances to the outside and increase in size, especially those near the micropyle, where they elongate until they are six to nine times longer than broad. The ovule bends over in such a way that these palisade-like cells get into close contact with the funicle. Whether any nutritive substances can pass directly from the funicle into these integumentary cells, is impossible to say. The cuticle over these elongated cells shows curious vescicles (Fig. 28), but no direct break or pores were visible in it. Later the epidermal cells turn black and form the thick outer coat of the testa.

Three fairly thick layers of cutin are present in the seed-coat: the first on the outer surface, the second between the outer and the inner integument and the third on the inner surface of the latter.

The nucellus is absorbed except in the chalaza where some nucellar cells are still visible in the ripe seed. The rostelliform appendix at the hilum mentioned by Bentham and Hooker, is formed from the elongated epidermal cells of the outer integument near the micropyle, and from enlarged epidermal cells of the upper part of the funicle at the point where this is attached to the seed. The abscission of the seed takes place between these two groups of cells.

Figs. 18—29. *Forbesia plicata.* 18. Megaspore mother-cell. 19. First reduction division of the megaspore mother-cell. 20. Functional binucleate megasporic cell, the upper one having degenerated. 21. Two nuclei of the functional cell moving apart. 22—23. Further development of the embryo-sac. 24. Mature embryo-sac after fertilization. 25. Two endosperm nuclei separated from each other by a membrane. 26. Multinuclear basal endosperm chamber forming a chalazal haustorium; above it some nuclei of the endosperm proper. 27. Longitudinal section through ovule showing the outer integument in contact with the funicle. 28. Elongated cells of the outer integument in contact with the funicle. 29. Seed-coat of the ripe seed. A. Antipodal cells. C. Cuticle. F. Funicle. II. Inner integument. OI. Outer integument. S. Synergidae. V. Vescicle in cuticle. Z. Zygote. Figs. 18—23 × 300; 24—26, 28, 29 × 200; 27 × 50.

When the flower opens the ovary chamber becomes filled with pectin mucilage staining bright red with ruthenium. This mucilage later forms the succulent substance of the fleshy fruit and is probably excreted by the funicles and wall of the ovary, as these structures show large areas not covered by cuticle. In younger stages they possess intact cuticles, but the growth of the cuticle does not keep pace with the expansion of their epidermal surfaces. The funicles become broad and flat, a large cavity developing in them around the vascular strand.

Discussion.

In *Pauridia minuta* the structure and the development of the ovule and seed are so greatly similar to those of Ianthe species that one can hardly believe that they belong to different genera. In both genera the development of the embryo-sac is normal and the embryo develops according to the Asterad type and in the ripe seed is still undifferentiated. The formation of the endosperm in Pauridia is similar to that of certain species of Ianthe, *viz.*, *I. aquatica*, *I. alba* and *I. minuta*, and the seed-coat in the two genera is similar in structure. The only difference lies in the smaller size of the ovule and seed and also of certain cells and tissues in Pauridia, *e.g.*, the nucellus and some cells of the testa.

This investigation confirms the view that Pauridia is very closely related to Ianthe (Hypoxis), and shows that Bentham and Hooker and Hutchinson were correct in placing Pauridia under the Hypoxideae as Bentham and Hooker tentatively did, or under the Hypoxidaceae as Hutchinson did. Brackett (1923) also states that the seeds of Pauridia are externally similar to those of Hypoxis, Curculigo and Molineria and that they should be classed together.

Too great stress should therefore not be laid on the presence of only one whorl of stamens in Pauridia, and the description of the Hypoxideae should be modified to include this genus. Pax (1930) placed the genus under the Haemodoraceae because of the absence of the outer whorl of stamens, but preliminary investigations in other members of the latter family show the development and structure of the ovule and seed to differ in certain respects from that of Pauridia and other members of the Hypoxideae.

In *Forbesia plicata*, another member of the Hypoxideae, the formation of the embryo-sac conforms to the Allium type (Maheshwari 1948), in which the 8-nucleate sac develops, after two further mitoses, from a binucleate cell regarded as the equivalent of two megaspores which have not separated. It therefore differs from the other members of the Hypoxideae investigated. Stenar (1925) found that even such a closely related plant as *Curculigo recurvata* shows the normal type of embryo-sac development.

In *Forbesia plicata* the nucellus is much larger than in species of Ianthe and especially in Pauridia, where it is very small indeed.

The Helobial endosperm development which occurs in *Forbesia plicata* is similar to that described by Stenar (1925, 1938, p. 281) in two species of Hypoxis and by the present author in *Ianthe Schlechteri.* The basal endosperm chamber, however, is of larger size and may be considered a chalaza haustorium. Schlimbach (1924) also mentions the presence of a large chalazal haustorium in an unidentified species of Curculigo. Probably this also originated from a basal endosperm chamber.

There seems to be a connection between the persistence of the antipodal cells and the formation of Helobial endosperm. With large persistent antipodals nuclear endosperm development takes place and no basal endosperm chamber is formed. With small antipodal cells which degenerate early, Helobial endosperm development occurs, the basal endosperm chamber taking in the position of the antipodals. Which is cause and which effect is impossible to say.

Forbesia plicata is more specialized than either Ianthe or Pauridia species. This is shown not only in the structure of the flower (the presence of the long rostrum), but also of the ovary and ovule, *e.g.*, (i) the elongation of the epidermal cells of the outer integument to make contact with the funicle ; (ii) the enlargement of the latter structure ; (iii) the development of mucilage within the ovary and the subsequent development of a fleshy fruit, and (iv) if the normal type is taken as primitive, the Allium type of embryo-sac development.

SUMMARY.

1. In *Pauridia minuta* the archesporial cell is hypodermal and remains in that position, the embryo-sac being covered only by a nucellar epidermis.

2. The four megaspores formed after the reduction division are usually in a T-shaped position and the chalazal one is functional. The development of the embryo-sac is of the normal type and the endosperm is formed by nuclear development, the antipodals enlarging somewhat and persisting for some time after the fertilization.

3. The embryo develops according to the Asterad type.

4. The structure of the seed-coat is similar to that in the Ianthe species.

5. As the development of the ovule and seed of *P. minuta* is similar to that of the species of Ianthe investigated, it is concluded that these

two genera are very closely related and that they should be classed together.

6. In *Forbesia plicata* the archesporial cell is hypodermal, but later the nucellar epidermis at the top becomes many-layered and forms a large cap above the egg-apparatus.

7. The Allium type of embryo-sac development takes place, and Helobial endosperm formation occurs, a chalazal haustorium being formed from the basal endosperm chamber. The antipodal cells degenerate soon after fertilization.

8. The development and structure of the seed-coat is explained.

9. The structure of the ovary and the ovule confirms the view that *F. plicata* is more specialized than species of Ianthe and Pauridia.

ACKNOWLEDGMENT.

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NOTES ON POLYGALACEAE AND SOME NEW SPECIES OF MURALTIA.

By Margaret R. Levyns.

Polygala.

Ten species of Polygala are recorded from the Cape Peninsula in Bolus and Wolley Dod's list of the flowering plants published in 1904. In the forthcoming flora of the Cape Peninsula this number is reduced to seven, the following species being omitted for the reasons given below. *Polygala virgata* Thunb. does not occur in the area except in cultivation or as an escape from gardens. *Polygala Dodii* Schlechter is merely a pubescent form of *Polygala Garcini* DC and therefore becomes a synonym under the latter species. The writer visited Castle Rock near Miller's Point, the locality in which the type specimen was collected. Here growing under bushes close to the sea were both the normal glabrous and the pubescent forms. In all respects except hairiness there is nothing to distinguish *P. Dodii* from *P. Garcini*. In many South African species of Polygala both hairy and glabrous forms occur within the species and if proof were needed that this character has no specific significance, it is provided by specimens of *Polygala Lehmanniana* E & Z preserved in the Guthrie Herbarium of the University of Cape Town. In these both glabrous and hairy shoots may be found on the same plant. *Polygala Zahlbruckneri* Hayek is the third species. The type specimen has not been seen by the writer but from the description (Ann. Hofmus. Wien XV 45 (1900),) it seems almost certain that it too is synonymous with *P. Garcini*. The writer knows the locality from which Penther obtained his type specimen and *P. Garcini* is abundant there.

Two changes of name are necessary in the remaining seven species. *P. ericaefolia* DC does not occur within the area and the plant thus named by Bolus and Wolley Dod appears to be *P. recognita* Chodat. The writer hopes in due course to see Chodat's type specimen but in the meantime is accepting this name for a common species of Polygala in the southern part of the Cape Peninsula. The species identified by Bolus and Wolley Dod as *P. macră* DC is not that species. In 1937 Mr. A. W, Exell, at that time a member of the staff of the British Museum, kindly examined a flower from the type specimen sent to him by Professor Hochreutiner. He confirmed the fact that it is certainly not the species growing on the Cape Peninsula and going by that name. *P. Pappeana*

E & Z appears to be the correct name for this species which has a fairly wide range of distribution in marshy places in the western part of the Cape Province. The species contains a number of geographical forms, a study of which is in progress.

The writer is grateful to Mr. Exell for the help he so willingly gave more than ten years ago. He compared some of the local species with specimens in herbaria in Europe thus enabling the writer to come to more definite conclusions than would have been possible had the work been confined to South Africa.

MURALTIA.

Muraltia in many ways is strikingly different from Polygala. In the latter genus all the species on the Cape Peninsula are easily distinguished while in the former separation of some of the species is a matter of considerable difficulty. Then too all the species of Polygala occurring within the area have a fairly wide distribution in South Africa. In Muraltia on the other hand, out of twenty-three species occurring on the Cape Peninsula no fewer than nine are local endemics, an unusually high proportion. The writer is at present engaged on a detailed study of this interesting and puzzling genus and feels somewhat diffident about publishing anything at this stage. However, there are species which must be described and named before the publication of the Flora of the Cape Peninsula which is now ready to be placed in the printer's hands. These species are described below. The first three in all probability have not been described hitherto. The remaining three, however, may well be species already named but so much confusion or uncertainty is attached to the names which are at present in use that it is thought better to give them new names as a temporary measure. *Muraltia Salteri*, described below may prove to be the same as *Muraltia satureoides* DC, a name at present applied in herbaria to a number of distinct species. The plant to which the name *Muraltia neglecta* is now being given is usually termed *Muraltia stipulacea* DC. This species is based on *Polygala stipulacea* L. (Mant. II 260), a species said to be the same as *Heisteria mitior* Berg, (Pl. Cap. 187). The writer has shown (Journ. S. Af. Bot. V 38, 1939), that *Heisteria mitior* Berg is unmistakeably the same as *Muraltia mixta* (L.f.) DC. The two figures cited by Linnaeus for *Polygala stipulacea* (Commel. Hort. II p. 193, t. 97 and Seb. Mus. II p. 63, t. 62, fig. 8) are quite clearly not the present species. Another possible name for the species is *Muraltia linophylla* DC., but Harvey regarded this as synonymous with *Muraltia filiformis* (Thunb.) DC and once more the element of doubt creeps in. The third species to which a new name, *Muraltia inconstans*, is being given is the species known at present as *Muraltia thymifolia* DC.

Thunberg who founded the species stated (Fl. Cap. p. 557) that *Polygala thymifolia* was the same as *Heisteria mitior* Berg. The species under discussion is different in many respects from that of Bergius.

When the writer has completed her study of Muraltia in South Africa she hopes to visit European herbaria when it may be possible to settle many of these problems. In the meantime new names, which in the end may prove to be superfluous, are being assigned so as to avoid further confusion.

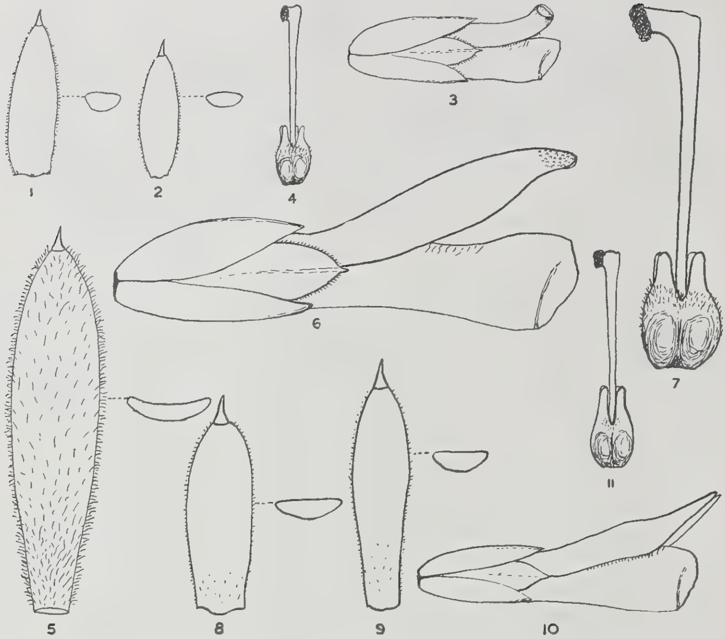
In Muraltia the leaves are often tufted. The leaves on the main stems (primary leaves) may be different in form and size from those on the short shoots in the axils of the primary leaves. The leaves of the axillary tuft are termed secondary leaves. Most species bear a profusion of small, sessile flowers among the leaves of the short shoots. Sometimes the whole plant is floriferous and no part of the plant can be described as purely vegetative. In other cases, and this is always true of very young plants, a few of the basal leaves never bear flowers in their axils. The primary leaves on these parts may be very much longer than usual and have a slightly different shape. All the descriptions given below apply to leaves in the flower-bearing part of the plant. All lengths of flowers quoted below are measured from the base of the calyx to the apex of the longest petal, excluding the crest on the keel.

Drawings. All leaves have a magnification of 5 diameters. All parts of the flower have a magnification of 10 diameters. In all cases the lower surface of the leaf is depicted. Flowers are drawn in side view with the crest removed.

1. **Muraltia curvipetala** Levyns (Figs. 1—4).

Suffrutex. *Folia* fasciculata, sessilia : primaria 4—5 mm. longa, subulata, cuspidata, supra plana, infra rotundata. *Corolla* (sine crista) circa 3 mm. longa. *Petala* lateralia oblonga, ciliata, reflexa, carinae in longitudine aequantia. *Stigma* sessile, laterale.

An erect undershrub, about 40 cm. high. Stems hirsute. Leaves densely tufted : primary leaves 4—5 mm. long, subulate, flat above, rounded below, widest near the base, spine-tipped, shortly ciliate : secondary leaves similar to the primary but usually somewhat concave above, narrowed slightly at the base. Flowers 3 mm. long, pink. Sepals a little more than half the length of the side petals, cuspidate, ciliate. Side petals about as long as the keel, oblong, ciliate except at the apex, the tips curving abruptly upwards and outwards. Stigma lateral, almost sessile on the slightly widened tip of the style. Fruit about as broad as long, the slender horns a little shorter than the rest of the fruit, the surface rough but not hairy : seed glabrous or nearly so.



Figs. 1—11. *M. curvipetala.* 1. Primary leaf and outline of transverse section. 2. Secondary leaf and outline of transverse section. 3. Flower. 4. Gynoeceum.
M. rosmarinifolia. 5. Primary leaf and outline of transverse section. 6. Flower. 7. Gynoeceum.
M. Pageae. 8. Primary leaf and outline of transverse section. 9. Secondary leaf and outline of transverse section. 10. Flower. 11. Gynoeceum.

Hab. Cape Province. Cape Division. Mountains from Kalk Bay to Muizenberg Reservoir at an altitude of about 1,000 ft.: Kalk Bay, *Levyns* 4151, (type in the Bolus Herbarium).

2. **Muraltia rosmarinifolia** Levyns (Figs. 5—7).

Suffrutex. *Folia* solitaria vel fasciculata, sessilia: primaria 8—15 mm. longa, linearia vel lanceolata, plana, cuspidata, supra canaliculata, infra villosa, ciliata. *Corolla* (sine crista) circa 7 mm. longa. *Petala* lateralia obtusa, apicem versus angustata, apice verrucosa, carinae in longitudine aequantia. *Stigma* patens, subarcuatum, obliquum.

A decumbent undershrub, young shoots sometimes erect. Stems villous. Leaves solitary or with axillary tufts: primary leaves from 8 to 15 mm. long, linear or lanceolate, flat, somewhat channelled above, spine-tipped, glabrous or almost so above, villous below, long ciliate : secondary leaves similar but shorter than the primary. Flowers about 7 mm. long, pink. Sepals about half as long as the keel, the inner cuspidate, ciliate, the outer obtuse or slightly mucronate, entirely glabrous. Side petals about as long as the keel, tapering towards the apex, obtuse, the tip verrucose outside. Style widening gradually, curved near the apex, the stigma oblique. Fruit with slender horns about as long as the hirsute, seed-bearing part. Seed globose, sparsely hispid.

Hab. Cape Province. Cape Division. West coast of the Cape Peninsula from Olifantsbosch to Platboom. Olifantsbosch, *Salter* 2843 (type in the Bolus Herbarium).

3. **Muraltia Pageae** Levyns (Figs. 8—11).

Suffrutex. *Folia* fasciculata, sessilia : primaria 5—6 mm. longa, oblongo-lanceolata, cuspidata, ciliata, supra plana vel paulum convexa, infra rotundata. *Corolla* (sine crista) circa 4 mm. longa. *Petala* lateralia apicem versus angustata, apice acutissima, carinae in longitudine paulum longiora. *Stigma* fere sessile, laterale.

An erect undershrub, 30 cm. high or less. Stems hispid. Leaves densely tufted : primary leaves 5—6 mm. long, oblong-lanceolate, flat or slightly concave above, rounded below, cuspidate, ciliate, wide at the base : secondary leaves as long as or a little longer than the primary, narrower, flat above, tapering somewhat to the base. Flowers about 4 mm. long, pink. Sepals mucronate, sparsely ciliate, the longest less than half as long as the side petals. Side petals linear, tapering to a fine acute point, a little longer than the keel. Style widening gradually, the stigma lateral on a very short arm. Fruit glabrous or nearly so, with slender horns, somewhat longer than the seed-bearing part. Seed globose, glabrous.

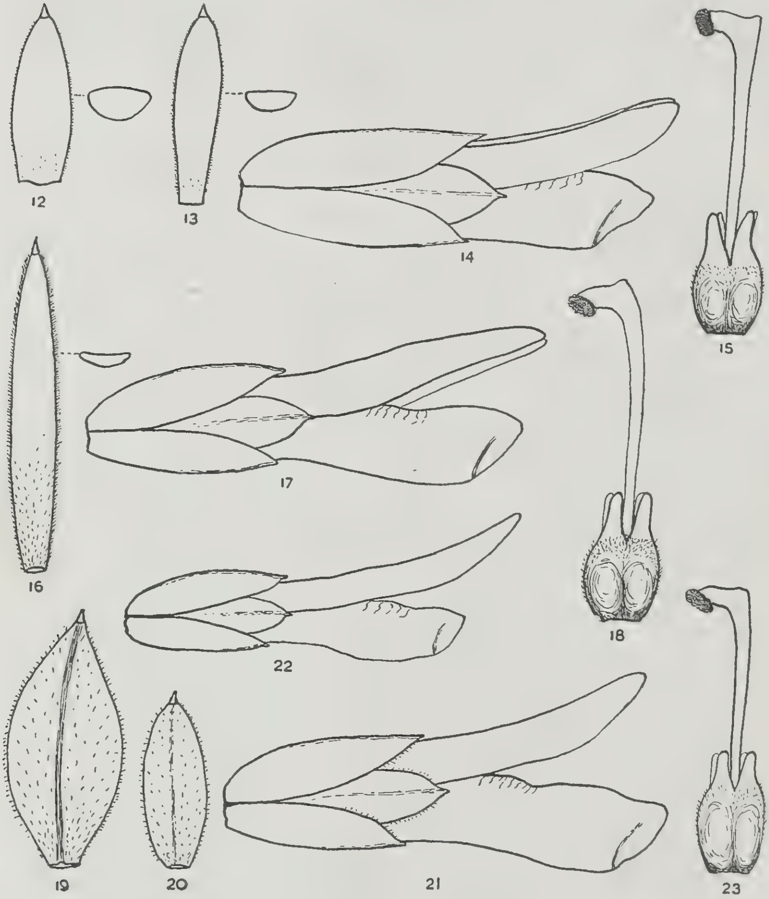
Hab. Cape Province. Cape Division. On sandy ground from Fish Hoek southwards. Between Smitswinkel and Buffels Bays, *Levyns* 6020 (Type in the Bolus Herbarium).

4. **Muraltia Salteri** Levyns (Figs. 12—15).

Suffrutex. *Folia* fasciculata, sessilia : primaria 7—10 mm. longa, subulata, cuspidata, supra plana vel paulum convexa, infra rotundata, breve ciliata. *Corolla* (sine crista) 6—7 mm. longa. *Petala* lateralia, obtusa, apicem versus angustata, carinae in longitudine aequantia. *Stigma* patens, subarcuatum, obliquum.

An erect or decumbent undershrub, 40 cm. high or less. Stems pubescent. Leaves densely tufted, spreading or recurved, sessile : primary leaves 7—10 mm. long, subulate, flat or convex above, rounded

below, wide at the base, tapering to a spine-like point, shortly ciliate with a few rough hairs elsewhere : secondary leaves similar to the primary but not as wide, narrowing slightly towards the base. Flowers 6—7 mm.



FIGS. 12—23. *M. Salteri.* 12. Primary leaf and outline of transverse section. 13. Secondary leaf and outline of transverse section. 14. Flower. 15. Gynoeceum.

M. neglecta. 16. Young primary leaf and outline of transverse section. 17. Flower. 18. Gynoeceum.

M. inconstans. 19. Primary leaf from the type specimen. 20. Primary leaf from a small tufted plant, *Levyns* 8317. 21. Flower (Type). 22. Flower from *Levyns* 8317. 23. Gynoeceum.

ong, pink. Sepals glabrous, cuspidate, about half as long as the side petals. Side petals about as long as the keel. Style widening gradually. curved near the apex, bearing an oblique stigma. Fruit broad, the slender horns about as long as the rest of the fruit, with a few hairs on the top between the horns and along the line of dehiscence : seed globose, sparsely hispid.

Hab. Cape Province : Cape Division : the lower slopes of Karbonkelberg, Hout Bay, *Levyns* 8954 (type in the Bolus Herbarium) : Fish Hoek, *Levyns* 7076 : between Smith's Farm and Vasco da Gama Peak, *Salter* 5766 and 8446. Caledon Division : Palmiet River Mouth, *Levyns* 7787 : Wortel Gat, near Hermanus, *Levyns* 8635. Bredasdorp Division : Agulhas, *Levyns* 8852.

This species appears to be confined to sandy soils containing lime.

5. **Muraltia neglecta** Levyns (Figs. 16—18).

Suffrutex. *Folia* solitaria vel fasciculata, sessilia : primaria 7—10 mm. longa, linearia, cuspidata, juvenilia ciliata, supra plana, infra paulum rotundata. *Corolla* (sine crista) 4—5 mm. longa. *Petala* lateralia obtusa vel raro acuta, carinae in longitudine aequantia. *Stigma* patens, subarcuatum, obliquum.

An undershrub, 30 cm. high or less, branching chiefly at the base. Stems glabrous or sparsely pubescent. Leaves solitary or scantily tufted : primary leaves 7—10 mm. long, linear, almost flat above, slightly rounded below, cuspidate, widest near the middle, long-ciliate when young, otherwise glabrous : secondary leaves when present similar but shorter. Flowers 4—5 mm. long, pink. Sepals acute, mucronate, sparsely ciliate, the longest about half as long as the side petals. Side petals linear, usually somewhat obtuse but occasionally acute, about as long as the keel. Style widening upwards, the stigma oblique at the tip of a curved arm. Fruit broadly oblong with slender horns about as long as the rest of the fruit, sparsely pubescent on the upper part of the ovary. Seed globose, sparsely hispid.

Hab. Cape Province. Cape Division. The lower slopes of Devils Peak in rhenosterveld, *Levyns* 5858 (type in the Bolus Herbarium).

This species is fairly widely spread in the Cape, Paarl and Malmesbury Divisions.

6. **Muraltia inconstans** Levyns (Figs. 19—23).

Suffrutex. *Folia* solitaria vel interdum fasciculata, subsessilia : primaria 6—10 mm. longa, plana, ovato-lanceolata vel lanceolata, cuspidata, juvenilia pubescentia, nervo medio subtus prominenti. *Corolla* sine crista) 6—7 mm. longa. *Petala* lateralia linearia, obtusa vel acuta, carinam in longitudine breviora, vel longiora vel aequantia. *Stigma* patens, subarcuatum, obliquum.

An erect or decumbent undershrub, 60 cm. high or less. Stems pubescent. Leaves solitary or some with axillary tufts : primary leaves 6—10 mm. long, flat, ovate-lanceolate or lanceolate, cuspidate, pubescent when young, scabrous later, the midrib prominent below : secondary leaves when present similar to the primary but smaller. Flowers 6—7 mm. long, pink or white. Sepals a little less than half as long as the side petals, glabrous, mucronate, the two inner ciliate, the outer sparsely ciliate or without hairs. Side petals longer than, as long as, or shorter than the keel, linear, obtuse or acute. Style slender widening towards the curved apex, the stigma lateral, oblique. Fruit broad with four slender horns, the horns longer than the seed-bearing part, scantily hispid. Seed globose, sparsely hispid.

Hab. Cape Province. Cape Division. Western slopes of the Cape Peninsula from Lions Head to Karbonkelberg : sandy flats near Retreat : slopes above Camps Bay, *Levyns* 8318 (type in the Bolus Herbarium).

This species is very variable even within a restricted area. It may be a stiffly erect bush or it may be low with a tufted habit. At other times it is decumbent. The leaves vary in size and shape. The relative lengths of the keel and side petals, in most species fairly constant, are here variable. In some plants most of the pollen grains are good whereas in others large numbers of bad grains are present. There are no morphological features in plants with a high proportion of bad pollen to suggest hybridity as a cause. When the species grows with *Muraltia Heisteria* hybrids are occasionally found but they are always intermediate in character, have completely sterile anthers and do not set seed. The species is a puzzling one and further study is required.

ACKNOWLEDGMENT.

The writer wishes to acknowledge her indebtedness to the S.A. Council for Scientific and Industrial Research. This paper was completed while holding a Senior Bursary. The writer also wishes to thank Captain T. M. Salter for helpful criticism.

REVIEWS.

VERNALIZATION AND PHOTOPERIODISM by A. E. Murneek and R. O. Whyte. A Symposium. Waltham, Mass. Chronica Botanica Co., 1948. $4.50. Johannesburg, Central News Agency.

This volume is the first in a series " Lotsya " which is to comprise specialised biological works. It deals with some aspects of plant investigation which have come to the fore only within recent years.

Investigation and more especially controlled experimental investigation of the physiological bases of plant development are of very recent date. At the present time they are centered on the more obvious features such as flower production. While a definite start has been made, the whole subject is one that is still in its initial phase and is one liable to considerable alteration in outlook as further experimental work is carried out.

This volume deals with some of the possible controlling factors for vegetative and for reproductive growth and the possible explanations of experiments on these. Quite a large volume of work has been done, some of which has received publicity beyond the immediate realm of the research worker. The volume itself is described as a " Symposium " and contains contributions from a number of persons in addition to the nominal authors. It is in fact a most useful and complete summarisation of work done up to date. As an indication of the fields covered the chapter headings may be enumerated. These are :— Foreword ; History of Research in Vernalization; History of Research in Photoperiodism ; Hormones in relation to Vernalization ; Wave Length Dependance and the Nature of Photoperiodism ; Photoperiodicity of Flowering under Short Day with supplemental light; Nutrition and Metabolism in relation to Photoperiodism ; Anatomical Changes in relation to Vernalization ; Length of Day in past geological Eras ; Vernalization and Photoperiodism in the Tropics ; Phenological Data as a Tool in the Study of Photoperiodic Requirements ; Thermoperiodicity. In addition there are three appendices (in German) on Photoperiodism in the Tropics, The Development of Photoperiodism, and The Genetics of Photoperiodism.

The book is not in any sense a popular one, indeed to any but the student of these special fields its reading is far from easy. It is addressed very distinctly to the specialist. As a summary and exposition of the present state of knowledge and as a means of bringing together the results of very widely scattered researches many of which are not at all readily available, it will be of great value to the research worker and should have an appeal to advanced students. Its publication, by focussing attention on what has been done, should stimulate research on a most fascinating and important field of study.

The book is very well printed though the type used for the literature references is perhaps unduly small. Though not bound it is issued in a strong paper cover. It is illustrated by many graphs and tables in the text and by twelve very well reproduced plates, three of which give portraits of the best known pioneer workers in these subjects.

If the continuation of the series is to be on the standard of the present volume, its success with research workers is assured.

R. S. ADAMSON.

DICTIONARY OF GENETICS by R. L. Knight. Waltham, Mass.: the Chronica Botanica Co.; Johannesburg: Central News Agency, Ltd. Price $4.50.

This is the second volume of "Lotsya," a serial publication devoted to biological subjects.

The time is ripe for the appearance of a dictionary of genetical terms. As might be expected in a young and vigorous science, terms have multiplied with great rapidity. Sometimes they are necessary, sometimes they are not. Occasionally new terms are coined when words expressing the same thing are already in existence. The author in his preface cites a striking case of this where ten different terms have been proposed to denote one particular region in a chromosome. It is therefore not surprising that the non-specialist scientist finds the reading of genetical literature a difficult task, as most of the terms used have not yet found their way into any standard dictionary. This dictionary will therefore be warmly welcomed as it gives short, clear definitions of the terms in use. Its scope is wide, for it covers not only genetics but the sister science of cytology. It includes large numbers of biological and ecological terms which are liable to appear in genetical papers.

Brevity and clarity are two desirable features in definitions. Occasionally, however, the author is too sparing of words and fails to make his meaning clear. To take a single example, brachymeiosis is defined as a "modified form of meiosis in which no second division occurs". This may be true but surely some reference to its place in the life cycle of certain Ascomycetes is essential? Another minor criticism is the way in which headings of the pages are arranged. The left-hand page always bears the name of the author and the title of the book. The right hand page provides the clue both to the starting point of the previous page and to its own concluding topic. This departure from the usual practice in dictionaries is a little disconcerting at first and in the opinion of the reviewer brings no compensating advantage.

These, however, are small flaws in an attrative and clearly printed volume. The scientific public is indebted to the author and publishers for producing an extremely useful book.

M. R. Levyns.

Biology of Pathogenic Fungi, edited by Walter J. Nickerson. Annales Cryptogamici et Phytopathologici, Vol. VI, 1947, Waltham, Mass.: The Chronica Botanica Co.; Johannesburg: Central News Agency, Ltd. Pp. 236, 9 plates. $5.

The fungi which are pathogenic to man are few in number ; but they are widely distributed and the diseases they cause are often so resistant to treatment that they present important public health problems.

The study of this interesting and important group of fungi has been hindered by a lack of mycological training in the clinicians whose observations of mycotic diseases constitute the main body of the published literature of medical mycology. Mycologists, on the other hand, are handicapped in dealing with this group by their lack of knowledge of the clinical aspects of the problems involved. The well-known variability of the fungi, both in lesions and when grown on culture media has contributed to the confusion which has arisen with regard to the taxonomy and nomenclature of the group.

The voluminous and often misleading literature has been discouraging to workers wishing to devote themselves to this extremely important field of mycological study.

Dr. Nickerson has done a service to investigators in collecting, in this volume, a number of short articles by recognised experts, summarising what has been accomplished in various phases of research on the biology of the pathogenic fungi. The contents include articles on the pathogenic Torulopsidoideae ; Pityrosporum ; and Coccidioides. An account of the genera causing Chromoblastomycosis includes useful lists of synonyms. Four chapters summarise what is known of the metabolism and biochemical characteristics of these fungi ; there is a short account of the action of sulphonamides and antibiotics on various members of the group ; and there is a useful chapter on the geographical distribution of systemic fungal diseases. Each chapter includes a list of references.

D. L. Olivier.

JOURNAL

OF

SOUTH AFRICAN BOTANY

VOL. XV.

PLANTAE NOVAE AFRICANAE.

"Ex Africa semper aliquid novi."—*Pliny.*

SERIES XXIX.

By Captain (S.) T. M. Salter, R.N. (Ret.), Miss G. J. Lewis, B.A. and

Miss W. F. Barker, B.Sc.

(With Plates VII—VIII).

Aspalathus neglectus Salter sp. nov. (Leguminosae—Papilionatae) § Sympetalae.

Frutex ramosissimus, ad 1·5 m. altus, *A. ciliari* L. vel *A. chenopodo* L. affinis, sed ambobus bractea florali simplici, haud trifoliolata differt: etiam ab *A. ciliari* calycis dentibus foliolisque subpungentibus et alis brevioribus: ab *A. chenopodo* foliolis minus pungentibus et vexillo latissime obovato vel suborbiculari.

A dense much branched shrub, up to 1·5 m. high: the stem grey, branchlets villous. *Leaves* fascicled: leaflets terete, usually straight, mostly 0·6—1·4 cm. long, scarcely 1 mm. broad, more or less pilose with tubercle-based hairs, subpungent, the spines soon brown-tipped. *Flowers* yellow, at length rusty red, terminal or apparently lateral on very short branchlets, more rarely 2—3 capitate. *Peduncles* scarcely 1 mm. long, villous, concealed by the leaf-tufts. *Bract* and *bracteoles* filiform, subpungent: bract 0·8—1·2 cm. long, arising at the base of the peduncle: bracteoles 7—8 mm. long, arising on the calyx tube. *Calyx* 1·2—1·5 cm.

long, the narrow-linear tapering subpungent teeth longer than the villous tube, the two upper slightly falcate and spreading. *Vexillum* 1·5—1·9 cm. long with a short claw, the lamina very broadly obovate or suborbicular, bright yellow and glabrous above, densely villous below, minutely cuspidate at the apex: laminae of the *alae* 8—9 mm. long, the claws only adnate to the staminal tube near the base: *carina* pale, 1·3—1·5 cm. long, suberect, obtuse, dorsally more or less pubescent, the claw adnate. *Ovary* 2 -ovuled, villous. *Legume* shortly stipitate, subovoid, obliquely acute at the apex, 7—8 mm. long, 1-seeded.

Hab. Cape Province. Cape Peninsula; near Exeter Avenue on the north slope of Wynberg Hill, below the Beacon. Alt. about 600 ft. *Salter* 9007 (*type* in the Bolus Herbarium). Stellenbosch Div.; Banhoek Valley, *C. Thorne* (S.A. Mus. 51212). Flowers Oct.—Jan.

In some respects this species looks like an intermediate between *A. ciliaris* L. and *A. chenopodus* L. and it may have been formerly mistaken for one of them. It differs, however, from both in its simple filiform floral bract, the bract in the two species mentioned being trifoliolate. The plant is much less pungent than *A. chenopodus*, a harshly prickly species with a capitate inflorescence and a very differently shaped vexillum, while *A. ciliaris* could not be described as spiny at all. There is a complete absence of any evidence of hybridity, at least 80 entirely similar bushes having been observed within a small area, nor are there any other species in the vicinity which could be suspected as the parents.

It is very remarkable that it should have escaped notice for so long, occurring as it does in quantity in such a well-collected area. The ground on which it grows is in a fork between two newly built roads and it has been much disturbed and opened up in recent years, having been formerly infested with Australian Wattle. Other species of the § Sympetalae, such as *A. chenopodus* L. and *A. astroites* L. are in the habit of springing up in abundance on cleared or burnt ground, the seeds probably lying dormant for years, and this may account for its sudden appearance. It is feared, however, that it will not long survive in its present habitat since the vicinity is being rapidly transformed into a residential area.

Like several of the larger species of Aspalathus it is evidently quick-growing and short-lived, the plants dying suddenly when looking apparently healthy. Near the middle of January five of the older plants in the colony were observed to have turned to various conspicuous shades of reddish brown or almost brick-red, had become brittle and were obviously dying, whereas a fortnight earlier they had been green and profusely covered with withered flowers. By the end of January about twelve of the bushes were dying.

The specimen S.A. Mus. 51212, from Stellenbosch Div., though the vexillum is rather narrower, appears to be inseparable from *A neglectus*.

Moraea papilionacea (L.f.) Ker. var. **Maythamiae** Lewis var. nov. (Iridaceae).

A typo foliis angustioribus parce pilosis et spathis glabris, differt.

Hab. Cape Peninsula, Rondebosch Common, *Salter* 8989, *Wilman* 73. (*Type* in South African Museum and Bolus Herbarium.)

Height about 15 cm. *Leaves* 2, 15—20 cm. long, 1—2 mm. wide, slightly folded, sparsely pilose. *Spathes* glabrous. *Flowers* deep salmon-pink, the claw and base of the blade of the outer segments yellow.

Flowering season August—September.

The much narrower leaves and glabrous spathes give a very distinct appearance to this variety but the flowers and other vegetative parts are exactly like those of the typical *M. papilionacea*, a species fairly common on the Cape Peninsula and elsewhere. The variety, however, appears to be extremely local and has so far only been recorded from a small area on the Rondebosch Common. Miss Mary Maytham, in whose honour the variety is named, first recorded and figured it during the course of her work on a book illustrating some of the flowers of the Cape Peninsula. It has been collected again recently by Miss A. M. Wilman, assistant at the Bolus Herbarium, and by Captain T. M. Salter. The flowers do not open until late in the afternoon, which is possibly the reason why this very distinct variety has not previously been recorded.

Lachenalia variegata Barker. (Liliaceae-Scilleae).

Planta 10—40 cm. alta. *Folium* plerumque 1, raro 2, lanceolatum vel ligulatum, supra glaucum, infra et basi minute purpureo-maculatum, ad 30 cm. longum et 2·5 cm. latum, apice interdum recurvum, marginibus undulatis et ampliatis. *Racemus* pauciflorus vel multiflorus: pedunculi maculae caeruleo-purpureae: pedicelli 1—2 mm. longi. *Flores* 8—10 mm. longi, patentes vel penduli: segmenta exteriora quam interiora valde breviora, maculis variegatis viridibus caeruleis purpureis ornata, apice tumidio brunneo vel viridi: segmenta interiora medium versus flavo-viridia, margines versus albentia, apicem versus leviter patentia, 2 superiora oppressa. *Stamina* perianthio aequantia vel leviter longiora.

Hab. Cape Province. Cape Peninsula: Paarden Eiland, *Salter* 7446 (*Type* in Herb. Nat. Bot. Gdns.), 22 Aug., 1938; *Lewis*, 22 Aug., 1938; Milnerton, *Barnes*, 11 Aug., 1929; *Lewis*, 22 Aug., 1938; Plumstead, *Arbuthnot*, Bolus Herb. 20454, Sept., 1931; *Schur*, 25 Sept., 1944; Bergvliet, *Salter* 7690, 23 Sept., 1938; Noord Hoek, *Barker*, Nat. Bot. Gdns.

479/44, 25 Sept., 1944; Karbonkelberg, *Compton* 16357, 29 Oct., 1944; *Leighton*, 28 Oct., 1944; Kalk Bay, *Barker* 4228, 16 Oct., 1944; Fish Hoek, *Schur*, 28 Sept., 1944; Glencairn, *Esterhuysen* 6019, 7 Sept., 1941; Klaasjager, *Salter* 7702, 12 Oct., 1938; Beyond Paulsberg, *Wolley Dod* 3191, 19 Sept., 1897; Cape Point, *Lewis*, 22 Aug. 1938; Flats West of Zeekoe Vlei, *Salter* 4864, 27 Sept., 1934; Cape Division: Raapenburg, *Guthrie* 60, 11 Aug., 1899; *Salter*, 25 Aug., 1938; Cape Flats, *Compton* 13456, 3 Sept., 1942; *Barker* 2980, 16 Sept., 1944; *Leighton*, 2 Sept., 1944; 3 miles West of Bellville, *Salter* 6246, 5 Sept., 1936; Kuils River, *Peers*; Groot Springfontein dunes, *Wasserfall* 230, 2 Aug., 1943; Stellenbosch Division: Faure Flats, *Arbuthnot*, Bolus Herb. 21652, 12 Aug., 1934; *Barker* 155, 12 Aug., 1934; Somerset West, *Bartlett*, Nat. Bot. Gdns. 934/23, 7 Aug., 1929; Malmesbury Division: Mamre Hills, *Compton* 15852, 31 Aug., 1944; 4 miles East of Yserfontein, *Salter* 6228, 27 Aug., 1936.

Bulb small, globose up to 2 cm. diam. *Inflorescence* 10—40 cm. high. *Leaves* usually one, rarely two, erect or spreading, sometimes recurved at the apex, lanceolate to strap-shaped with thickened undulate margins, blue-green above, finely blue-purple spotted below and on the clasping base, up to 30 cm. long and 2·5 cm. broad. *Raceme* few to many flowered: peduncle blue-purple spotted: pedicels 1—2 mm. long. *Flowers* 8—10 mm. long, spreading or pendulous: outer segments distinctly shorter than the inner, with variegated spots of green, blue and purple, the apical swelling dark brown or green.

This plant is one of several species which were wrongly included under the name *L. orchioides* Ait. in old collections. The typical form is frequent on sandy flats, when the plants are usually robust with strong variegated markings and the stamens included, the mountain form is more slender, with the flowers paler and the stamens becoming exserted.

Lachenalia capensis Barker. (Liliaceae-Scilleae).

Planta 16—40 cm. alta. *Folium* plerumque 1, interdum 2, lanceolatum vel ligulatum, pallide viride, supra interdum obscure maculatum, ad 33 cm. longum et 3 cm. latum. *Spica* multiflora: pedunculus pallide viridis, obscure maculatus, pedicellis brevissimis ad 1·5 mm. longis vel absentibus. *Flores* 1—1·5 cm. longi, patentes: segmenta exteriora quam interiora breviora, basi pallidissime caerulea, apicem versus gradatim pallidissime flava: segmenta interiora albentia, medio pallidissime flava, apice vix patentia, 2 superiora oppressa. *Stamina* perianthio aequantia vel breviter exserta.

Hab. Cape Province. Cape Peninsula: Wildschutskraal, *Barker* 3883 (*Type* in Herb. Nat. Bot. Gdns.) 10 Oct., 1945; Kogelfontein, *Salter* 8528, 23 Oct., 1940; Steenberg, *Compton* 13652, 13 Sept., 1942; Hout Bay, *Walgate*, 5 Sept., 1941; Rocky slopes Smitswinkel Bay, *Wolley Dod* 3087, 19 Sept., 1897; Castle Rocks near Millers Point, *Pillans* 9884, 18 Oct., 1944; Flats near Rondebosch, *Wolley Dod* 379, 12 Aug. 1895.

Bulb small globose, up to 2 cm. diam. *Inflorescence* 16—40 cm. high. Leaves usually one occasionally two, erect or spreading, lanceolate—strap-shaped, pale green, unspotted or faintly spotted above, up to 33 cm. long and 3 cm. broad, often with a clasping base. *Spike* many flowered: peduncle pale green, faintly spotted: pedicels wanting or very short, up to 1·5 mm. long. *Flowers* 1—1·5 cm. long, spreading: outer segments shorter than the inner, very pale blue at the base, shading to very pale yellow at apex, inner segments whitish, very pale yellow down the middle, scarcely spreading at the apex, the two upper overlapping. *Stamens* as long as the perianth or slightly exserted.

Previously included in the species *L. orchioides* Ait. or *L. glaucina* Jacq., this plant is sufficiently distinct to merit specific rank. Its inner segments are not spreading and recurved as in those species.

Lachenalia glaucina Jacq. var. **parviflora** Barker. (Liliaceae-Scilleae).

Flores minores ad 1·2 cm. longi. *Segmenta* perianthii exteriora saturate caerulea, basi gradatim violacea: segmenta interiora violacea.

Hab. Cape Province. Cape Peninsula: Fireguard near Mostert Ravine *Wolley Dod* 380 (*Type* in Bolus Herb.) 12 Sept., 1895; Under pine trees at Observatory, *D. Davies*, 20 Aug., 1946; Devils Peak, *Guthrie* 1248, 8 Sept., 1892; Tokai Flats, *Guthrie*, 1289, Sept., 1892.

Flowers small up to 1·2 cm. long: outer segments deep blue at base shading to violet: inner segments violet.

This variety differs from the typical form only in the size of the flowers which suggested the specific name.

Wachendorfia parviflora Barker. (Haemodoraceae).

Planta 10—30 cm. sed plerumque nana, 10—20 cm. alta. *Folia* linearia vel lanceolata, quam inflorescentia plerumque longiora, caeruleo-viridia, villosa ad 36 cm. longa et 2 cm. lata. *Inflorescentia* ramis numerosis brevissimis congestis induta. *Bracteae* herbaceae virides, semper erectae, interdum flores excedentes. *Flores* languide flavi, deinde brunnei, perianthii segmentis angustis 1·5—2·5 cm. longis, 3—6 mm. latis, superiore plerumque angustiore. *Stamina* quam segmenta duae partes breviora.

Hab. Cape Province. Cape Peninsula: Camps Bay, *Salter* 7457 (*Type* in Herb. Nat. Bot. Gdns.) 26 Aug., 1938; Eastern slopes of Lions Head, *Kensit*, Sept., 1913; Kirstenbosch, Clearing North of Window

Stream, *Esterhuysen* 11844, Sept., 1945; Raapenburg, Mowbray, *Guthrie* 1134, 23 Aug., 1891; By Krombooms River, Rondebosch, *Wolley Dod* 527, 12 Aug., 1895; Milnerton, *Pillans*, Sept., 1913; Clovelly, *Walgate*, 25 Aug., 1941; Glencairn, *Esterhuysen* 6020, 6 Sept., 1941; *Esterhuysen*, 7 Aug., 1941; Chapmans Bay, *Wolley Dod* 1751, 15 Sept., 1896; Slangkop River, *Wolley Dod* 3317; Cape Division: Melkbosch Road, Compton 12036, 18 Oct. 1941, (fruiting); Durbanville, *Barker* 2060, 16 Sept., 1942: Malmesbury Division: Between Blaauwberg and Mamre, *Barker* 931, 14 Sept., 1940, (fruiting); Mamre Hills, *Compton* 17369, 12 Sept., 1945; Mamre Road, *Esterhuysen* 5247, 15 Sept., 1940; Near Darling, *Esterhuysen* 5246, 15 Sept. 1940; Between Darling and Ysterfontein, *Barker* 4600, 23 Aug., 1947; Piquetberg Division: at foot of Piquetberg Mtn., *Schlechter* 5231, 8 Sept., 1894; Clanwilliam Division; Lamberts Bay, *Burrell*, Nat. Bot. Gdns. 2023/35, 20 Aug., 1936, and 12 Sept., 1941, (fruiting); Nardouw, *Barker* 4747, 14 Sept., 1947; Bosch Kloof, Cedarberg, *Compton* 9526, 22 Sept., 1940; Pakhuis Pass, *Lewis*, Bolus Herb. 22264, Sept., 1937; Olifants River Valley, *Pearson* 7102, 22 Sept., 1911; Van Rhynsdorp Division: 6 miles from Klaver, Krantz, *L. Bolus*, Aug., 1932; Worcester Division: Romans River, *Compton* 11652, 14 Sept., 1941; Robertson Division; McGregor, *Barker* 1101, 24 Sept., 1941, (fruiting); *Esterhuysen* 5245.

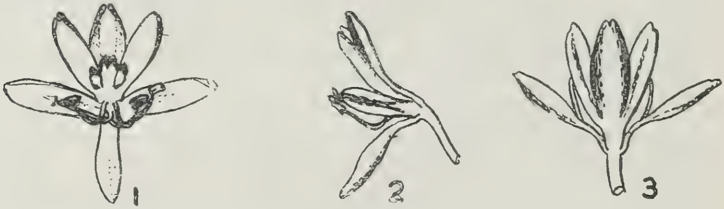


FIG. 1. *Wachendorfia parviflora* Barker. 1. Flower, front view. 2. Flower, side view. 3. Flower, back view, nat. size. *Del.* W. F. Barker.

Plant usually dwarf 10—30 cm. high. *Underground stem* small, ovate-oblong, 1—1·5 cm. diam. *Leaves* erect or spreading, linear to lanceolate, usually longer than the flowering stem, blue-green, softly hairy, up to 36 cm. long and 2 cm. broad. Inflorescence dense, with numerous very short, dense branches. *Bracts* herbaceous, green, always erect, sometimes produced beyond the flowers. *Flowers* dull yellow, fading brownish, segments narrow, 1·5—2·5 cm. long and 3—6 mm. broad, the upper segments usually broader than the rest. *Stamens* two-thirds the length of the perianth. *Capsule* broader than long, carpels obtuse.

No description of this plant can be traced, nor has it been illustrated; which is surprising, as it is a widely distributed species, with a distinctive dwarf habit, herbaceous erect bracts, and flowers with very narrow segments, unique in the genus. It occurs occasionally on hillsides and mountain slopes. In old collections it has been misidentified as *W. paniculata*, var. *tenella*.

Wachendorfia brachyandra Barker. (Haemodoraceae).

Planta 20—65 cm. alta. *Folia* linearia vel lanceolata, sparse pilosa vel glabra, luteo-viridia, ad 40 cm. longa et 2·5 cm. lata. *Inflorescentia* paniculata, ramis superioribus plerumque brevibus et plus minusve aequilongis, inferioribus 1—2 valde longioribus. *Flores* flavescentes, maculis atro-brunneis: perianthii segmenta 1—2 cm. longa, 7 mm. lata. *Stamina* quam segmenta in longitudine dimidia, haud ferme divergentia.

Hab. Cape Province. Cape Peninsula: Kirstenbosch, *Barker* 1096 (*Type* in Herb. Nat. Bot. Gdns.) 14 Oct. 1946; *Barker* 203, 1 Oct. 1936; *Barker* 328, 18 Oct., 1937; *Barker* 333, 21 Sept., 1938; *Esterhuysen* 492, Oct., 1935, (fruiting); *Walgate*, 12 Nov., 1941, (fruiting); Newlands House Estate, *Salter* 8777, 26 Oct., 1943; Hiddingh Estate, *Barker* 2697, 25 Nov., 1943, (fruiting); Bakoven, *Barker* 3231, 26 Oct., 1944; Glencairn, *Compton* 11620, 6 Sept., 1941; Vlakkenberg, *Compton* 20193, 17 Oct., 1947; Cape Division: Strandfontein, *Compton* 13692, 18 Sept., 1942; Caledon Division: Sir Lowrys Pass, *Barker* 3383, 19 Nov., 1946; Elgin, *Barker* 3365, 19 Nov., 1944; Malmesbury Division: Mamre Hills, *Compton* 9826, 12 Oct., 1940; *Slender form.* Cape Division. Cape Peninsula: Kirstenbosch, *Walgate*, 12 Nov., 1941; Modderdam, *Salter* 8718, 8 Dec., 1941; Witsands, *Salter* 8695, 10 Nov., 1941, (fruiting); *Salter* 8543, 23 Oct., 1940.

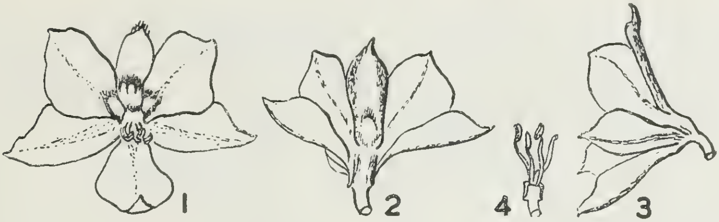
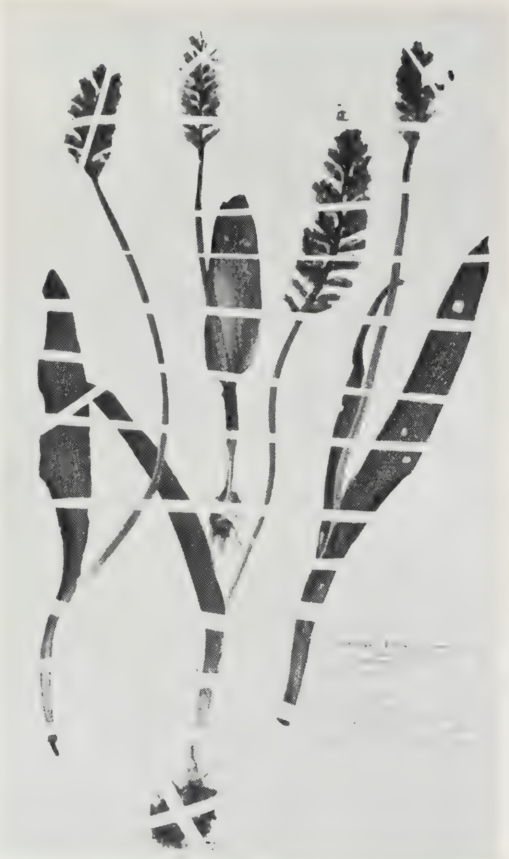


Fig. 2. *Wachendorfia brachyandra* Barker. 1. Flower, front view. 2. Flower, back view. 3. Flower, side view. 4. Gynaecium, nat. size. *Del.* W. F. Barker.

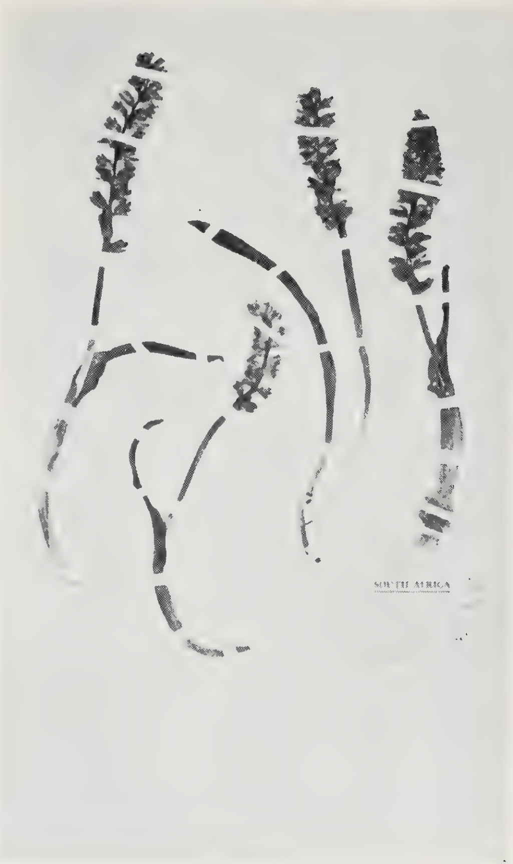
Plant 20—65 cm. high. *Underground stem* small, globose-ovate oblong 1—1·5 cm. diam. *Leaves* erect or spreading, linear to lanceolate,

sparsely hairy to glabrous, yellow-green, up to 40 cm. long and 2·5 cm. broad. *Inflorescence* a panicle, the upper branches usually short and more or less the same length, one or two of the lowest much longer. *Upper bracts* oblong ovate acuminate, submembranous, erect or spreading. *Flowers* apricot-yellow, the markings dark: segments 1—2 cm. long and 7 mm. broad. *Stamens* half as long as the perianth. *Capsule* broader than long, carpels obtuse.

This plant which is easily distinguished by its short stamens, is common on hillsides and flats, usually in damp places or beside streams. Occasionally a very slender form occurs with the leaves nearly terete, and the whole plant about 15 cm. high.

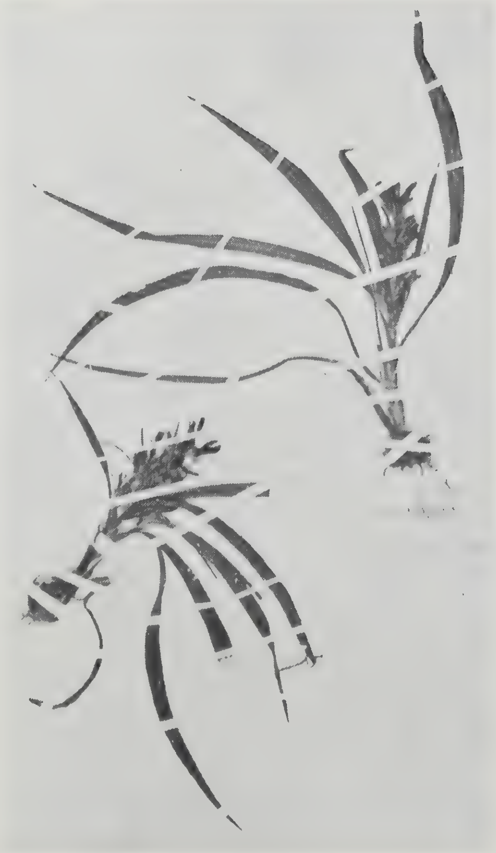


Lachenalia capensis Barker (*Barker* 3883)

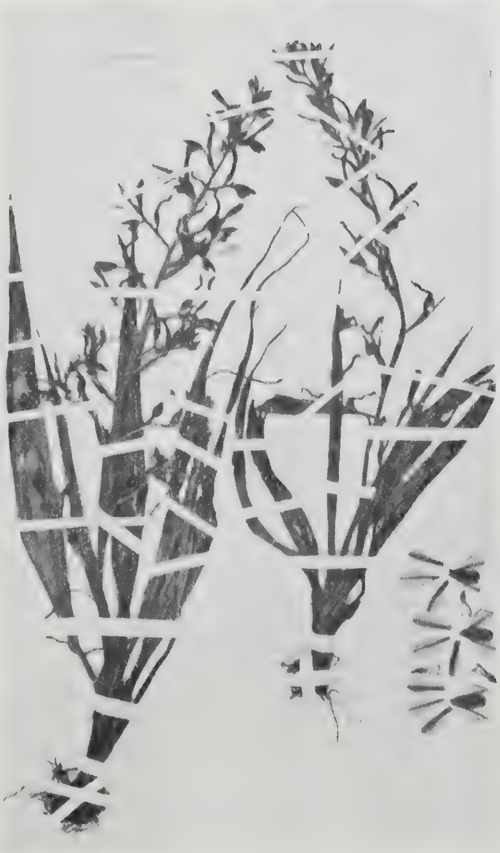


Lachenalia variegata Barker (*Salter* 7446).

PLATE VII.

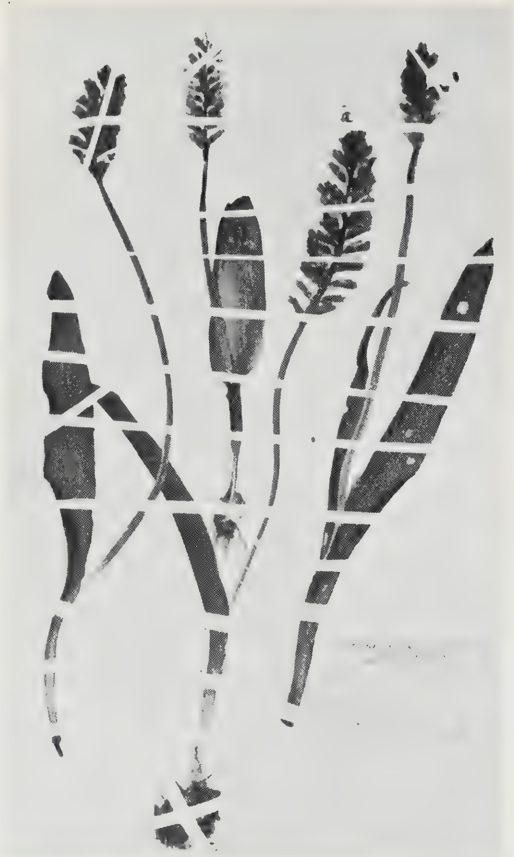


Wachendorfia parviflora Barker (*Salter* 7457).

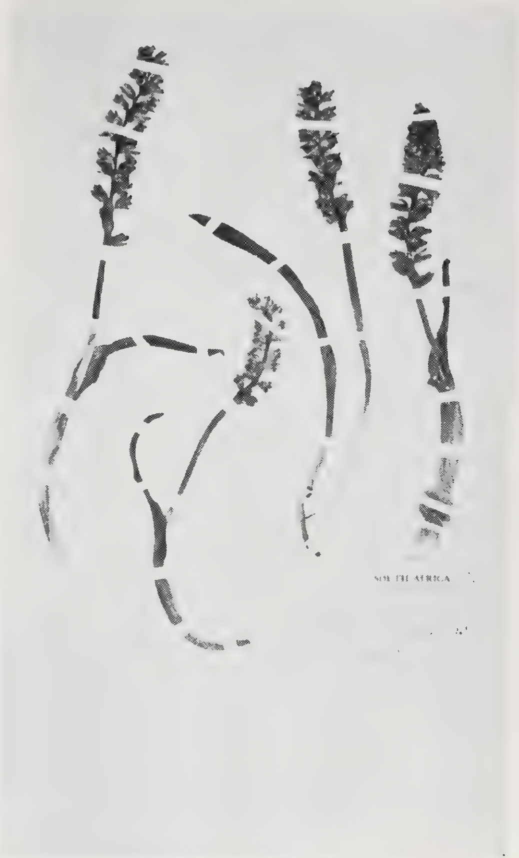


Wachendorfia brachyandra Barker (*Barker* 1096).

PLATE VIII.

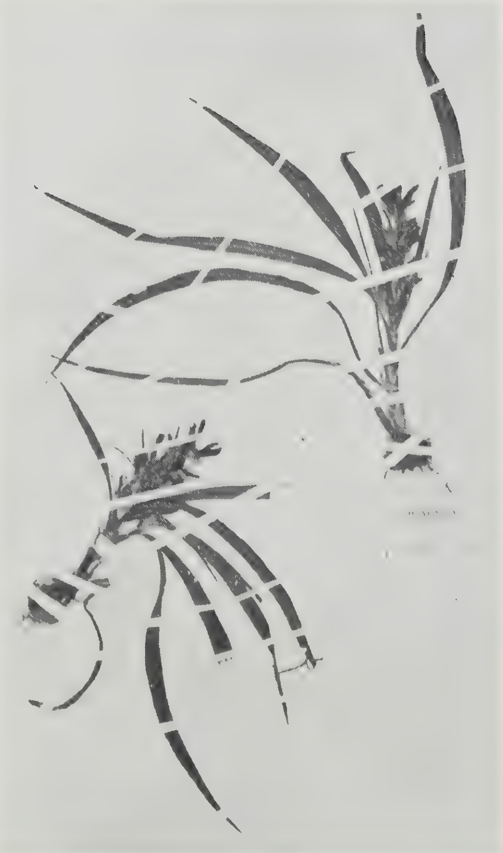


Lachenalia capensis Barker (*Barker* 3883)

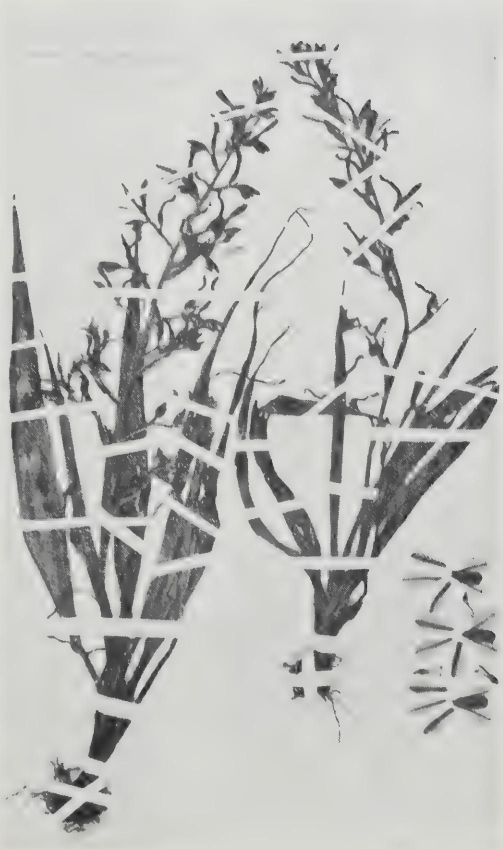


Lachenalia variegata Barker (*Salter* 7446).

PLATE VII.



Wachendorfia parviflora Barker (*Salter* 7457).



Wachendorfia brachyandra Barker (*Barker* 1096).

PLATE VIII.

THE IDENTITY OF ADIANTUM AETHIOPICUM L.

By E. A. C. L. E. Schelpe.

An examination of the type material of *Adiantum aethiopicum* L. in the Linnean Herbarium has made it clear to the author that Sim (1917) misidentified this species in South Africa. This confusion probably resulted from the grouping of *A. aethiopicum* L. and *A. poiretii* Wikstr. in one species, as Hooker and Baker did in their Synopsis Filicum (1874). Kuhn (1869) and later Christensen (1932) in his "Pteridophyta of Madagascar", separated the two species correctly. Both these authors used the position of the vein endings in the sterile pinnules as the key character.

Linnaeus (1760), in the tenth edition of the Systema Naturae, described *A. aethiopicum* with "frondibus supradecompositis; pinnis integris rotundatis crenatulis pedicellis capillaribus." In the second edition of the Species Plantarum (1763), he altered this description slightly and added to it:" frondibus supradecompositis; pinnis integris rotundatis crenatis petiolatis capillaribus. Adiantum fruticosum aethiopicum pinnulis amplis subrotundatis superne dentatis media pinnarum parte petiolis insidentibus." Here, Linnaeus makes a reference to a plate (t.253, f.2) of a sterile frond in Plukenet's Almagestum (1696), which he refers to his *A. aethiopicum.* The detail in the drawing is insufficient to allow definite identification, but since the plant from which the figure was drawn was said to have been collected at the Cape, the plate possibly represents either *A. aethiopicum* or *Adiantopsis capensis* (Thbg.) Fee.

There are three specimens of *A. aethiopicum* in the Linnean Herbarium (1252/15, 1252/16, 1252/18). The first, regarded as the type specimen, which is annotated " Adiantum aethiopicum" by Linnaeus himself, comprises two fronds, mainly sterile, attached to a rhizome; the pinnule margins are serrate, with the veins ending in the apices of the serrations. The angle of the bases of the pinnules varies between 30° and 170°; the few fertile pinnules bear one or two sori. The second specimen is marked "CBS", an abbreviation for "Caput bonae spei". The third specimen, bearing fronds which are mainly fertile, is marked "Sp", probably indicating that it was collected by Sparrman. No specimens of *A. poiretii* were seen in the Linnean Herbarium.

A. aethiopicum is most easily distinguishable from *A. poiretii* by two characters; (i) the situation of the vein endings, and (ii) the serration of the sterile pinnules in the former. In *A. aethiopicum*, the margins of the sterile pinnules are fairly regularly serrate with all the veins ending in the apices of the serrations. (Fig. 1, a-c.) In *A. poiretii*, the margins of the sterile pinnules are irregularly crenate to a varying degree with the veins often ending in the sinuses between the crenations or slightly to one side of them (Fig. 1, f.)

The shape of the indusia and the number of sori per pinnule may also prove useful characters in the identification of many individuals of this group of species. In *A. aethiopicum* the mature indusia are orbicular to orbicular-reniform (Fig. 1,b), whereas in *A. poiretii* the mature indusia are widely reniform to lunate and occasionally almost straight (Fig. 1,d,e.) South African specimens of *A. aethiopicum* usually possess one or two sori per pinnule (occasionally three); most of the South African material of *A. poiretii* exhibits fertile pinnules bearing four to ten sori each. Occasionally, some of the pinnules on a frond may bear less, and at the other extreme, specimens of *A. poiretii* have been seen bearing up to fifteen sori per pinnule.

Although the shape of the pinnules and the angle of their bases have been used to differentiate between these two species, wide variation of these two characters may often be found in pinnules on the same frond. However, it may be noted that in *A. aethiopicum* the pinnules are usually cuneate with basal angles between 30° and 90°, and in *A. poiretii* rather more reniform with basal angle usually between 80° and 110°.

In *A. poiretii* the pinnules often become detached from the secondary rachises of the frond on drying, both in their natural habitat and on herbarium sheets. This phenomenon has not been observed to happen in *A. aethiopicum.*

A. cuneatum L. & F., a South American species which is common in cultivation and has apparently "escaped" about Durban, may be distinguished from *A. aethiopicum*, since the veins of *A. cuneatum* regularly end in sinuses between crenations on the margins of the sterile pinnules.

SYNONYMY

The synonymy of *A. aethiopicum* L. is as follows: *Adiantum aethiopicum* Linnaeus in Syst. Nat., ed. x, 2, 1329 (1759) et in Sp. Pl., ed ii, 1560 (1763); Hk. & Bkr., Syn. Fil., ed ii, 123 (in part) (1874); Christ, Farnk. d.Erde, 139 (in part) (1897); Engler & Prantl. Nat. Pfl., 1, 4, 286 (1902); Christensen, Ind. Fil., 23 (1906) et Dansk. Bot. Arkiv, 7, 122 (1932).

Adiantum assimile Swartz, Schrad. Journ., 1800^2, 2, 83 (1801).

Adiantum trigonum Labill., Nov. Holl. pl. spec., 2, 99, t.248, f.2 (1806).

"*Adiantum Poiretii* Wkstr." Sim, Ferns of S.Afr., ed ii, 247, t.137 (1917).

DISTRIBUTION

According to Christensen (1906), *A. aethiopicum* occurs in tropical and South Africa, Australia and New Zealand and *A. poiretii* in tropical and subtropical Africa, Mexico, tropical South America and east peninsular India. Specimens of *A. aethiopicum* from Australia, New Zealand and South Africa and specimens of *A. poiretii* from South Africa and east Central Africa, Madagascar, Tristan da Cunha, Mexico and South America have been seen by the author.

In South Africa, *A. aethiopicum* is apparently confined to the Cape South-western Region, whereas *A. poiretii* is widely distributed and frequent in the eastern Cape province, the Natal midlands and the eastern parts of the Transvaal but has been recorded from the Cape South-western Region.

A number of South African specimens of these two species in South African herbaria, the herbarium of the Royal Botanic Gardens, Kew, the herbarium of the British Museum of Natural History and the Fielding Herbarium at Oxford have been examined and are cited.

Adiantum aethiopicum L.

CAPE PROVINCE. CALEDON: Elgin, *Compton* 13475 (Kb, P); Hottentots Holland, *Zeyher s.n.* (SAM). CAPE PENINSULA: Devils Peak, *Guthrie* 1323 (UC), *Pillans* 2701, *Wilms* 3917*a* (BM), *Wolley Dod* 547 (K), *Zeyher* 4638 (SAM); Kirstenbosch, *L. Bolus s.n.* (UC), *Compton s.n.* (UC), *Middlemost s.n.* (Kb), *Moss* 6259 (W), *Pearson s.n.* (P); Orange Kloof, *Gamble s.n.* (K); Rondebosch, *Levyns s.n.* (UC), *Pappe s.n.* (B), *Zeyher s.n.* (SAM); Roundhouse, *Wilms* 3917 (K); Simons Bay *Prior s.n.* (K); Simonstown, *Browning s.n.* (B); Table Mountain, *Burke s.n.* (B.M.), *Drege s.n.* (BM), *Ecklon s.n.* (K), *D'Urban s.n.* (F), *Harvey s.n.* (BM), *Prior s.n.* (K), *Rawson s.n.* (SAM, TM), *Zeyher s.n.* (B); Wynberg, *Wallich s.n.* (BM). KNYSNA: Plettenberg Bay, *Rex s.n.* (K). PAARL: Fransch Hoek, *Moss* 10356 (W). RIVERSDALE: Riversdale, *Muir* 3409 (P). STELLENBOSCH: Jonkershoek, *Garside* 1669 (K), *Levyns s.n.* (UC). SWELLENDAM: Tradouw Pass, *Barnard s.n.* (SAM). WELLINGTON: Wellington, *Knobel s.n.* (TM). WORCESTER: Worcester, *Zeyher s.n.* (K).

Without locality: *Burchell* 274, 436, 5578 (K), *McCleland s.n.* (F), *Pappe s.n.* (K).

Adiantum poiretii Wikstr.

CAPE PROVINCE. ALBERT: Albert, *Cooper* 1790 (K). BEDFORD: Bedford, *Holland s.n.* (Kb); Kagaberg, *Galpin* 14 (P). CAPE PENINSULA: Kirstenbosch, *Compton s.n.* (UC); Orange Kloof, *Pillans* 3766 (B); Simons Bay, *MacGillivray* 382 (K); Slangulie, *Marloth* 1669 (P); Table

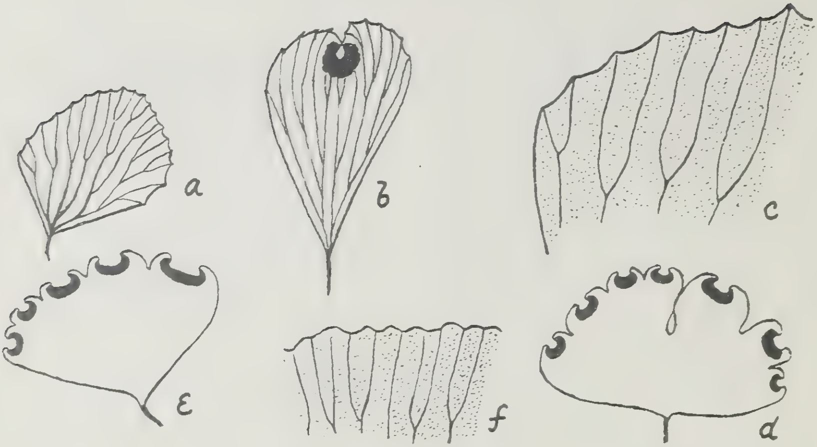


Fig. 1. *Adiantum aethiopicum* L. (*a*) Sterile pinnule (× 4) (*McCleland s.n.* (F)). (*b*) Fertile pinnule (× 4) (*McCleland s.n.* (F)). (*c*) Margin of sterile pinnule (× 8).
Adiantum poiretii Wikstr. (*d*), (*e*) Fertile pinnules (× 2) (D'Urban s.n. (F)). (*f*) Margin of sterile pinnule (× 8).

Mountain, *Blagrave s.n.* (K), *Harvey s.n.* (BM), *Milne* 279 (K), *Prior s.n.* (K). Engcobo: Engcobo, *Flanagan* 2780 (P), *McLoughlin* 88 (TM). Idutywa: Idutwya, *Pegler* 706 (P). Kingwilliamstown: Keiskamma Hoek, *Knight s.n.* (F); Perie, *Flanagan s.n.* (P), *T. R. Sim s.n.* (P). Mount Currie: Mount Currie, *Edwards* 41 (NU). Queenstown: Gwatyn, *Galpin* 8195 (P). Somerset East: Boschberg, *MacOwan* 1700 (BM, K, TM); Somerset East, *Bolus* 309 (B). Stockenstrom: Katberg, *Adams* 172 (NU). Umtata: Bazya, *Baur* 217 (K).

Without locality: *Burchell* 3120 (K).

NATAL. Bergville: Cathedral Peak Area, *Bursell* 85 (NU), *Esterhuysen* 12867 (B), *Schelpe* 389 (NU, PU); Natal National Park, *Bottomley s.n.* (P), *Doidge s.n.* (P), *Mogg* 4212 (P), *Schelpe* 1252 (NU). Dundee: Biggarsberg, *Wilms* 1763*a* (BM), *Sutherland s.n.* (K). Estcourt: Cathkin Peak Area, *Howlett* 33 (N, P), *Hillary* 96 (NU); Champagne Castle, *Bayer* 1448 (N, NU); Dalton Bridge, *Acocks* 11543 (N), *Wright, West & Acocks* 26 (B, N, P); Giants Castle, *Symons* 315 (TM); Mooi River, *Lindahl* 83 (NU). Himeville: Himeville, *Webb* 118 (NU). Impendhle: Impendhle, *Clarkson* 135 (N, NU). Klip River: Van Reenens Pass, *Schweickerdt s.n.* (TM). Lions River: Balgowan, *Fisher* 643 (NU); Karkloof, *Rycroft* 538 (NU); Lidgetton, *Mogg s.n.* (P);

Nottingham Road, *McClean* 902 (N). POLELA: Bulwer, *Allsopp* 830 (NU), *Clarkson* 174 (N, NU), *Henkel s.n.* (NU); Donnybrook, *Doidge s.n.* (P); Highbury, *Doidge s.n.* (P). UMGENI: Baynes Drift, *Bursell* 105 (NU); Pietermaritzburg, *Graham* 78 (NU), Guthrie *s.n.* (P).

Locality unknown: Tweekloof, *Thode A*1200 (P). Without locality: *Bolton s.n.* (BM), *Gerard* 502 (BM, K).

BASUTOLAND. Leribe, *E. P. Phillips* 593 (K, SAM).

ORANGE FREE STATE. ZASTRON: Kadziberg, *Rehmann* 3966 (K). Without locality: *Cooper* 1052 (BM, K).

TRANSVAAL. BARBERTON: Barberton, *Williams s.n.* (TM); Nelspruit, *Bosman s.n.* (P). BELFAST: Rietvlei, *Burtt Davy* 1235 (TM). ERMELO: Mavieriestad, *Pott* 4841 (B, TM). LETABA: Letaba River, *Junod* 2447 (TM); Magoebas Kloof, *Enslin & Schweickerdt s.n.* (NU, PU), *Gerstner* 5832 (P); LYDENBURG: Lydenburg, *Atherstone s.n.* (K); Mariespkop, *Van Son s.n.* (TM). PIETERSBURG: Haenartsburg, *Eastwood s.n.* (P, TM); The Downs, *Junod* 4042 (P, TM). PILGRIMS REST: Graskop, *V. Wager* 174 (P); Pilgrims Rest, *V. Wager* 181 (P). WAKKERSTROOM: Volksrust, *Mogg s.n.* (P).

BECHUANALAND PROTECTORATE. Mochudi, *Harbor s.n.* (*Rogers* 66331) (W).

SOUTHERN RHODESIA. Essexvale, *Borle s.n.* (Kb). Ironmask Hill, *F. Eyles* 328 (B, BM, P) Mazoe, *Holland s.n.* (Kb). Melsetter, Lessops Pass, *Fisher* 1259 (NU). Salisbury, *Holland s.n.* (Kb).

B.	Bolus Herbarium, Capetown.
BM.	Herbarium, British Museum of Natural History, London.
F.	Fielding Herbarium, Oxford.
K.	Herbarium, Royal Botanic Gardens, Kew.
Kb.	National Botanic Gardens, Kirstenbosch.
N.	Natal Herbarium, Durban.
NU.	University of Natal (Botany Dept.), Pietermaritzburg.
P.	National Herbarium, Pretoria.
PU.	University of Pretoria, Pretoria.
SAM.	Herbarium, South African Museum, Capetown.
TM.	Herbarium, Transvaal Museum, Pretoria.
UC.	University of Capetown (Botany Dept.), Cape Town.
W.	University of the Witwatersrand (Botany Dept.), Johannesburg.

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SUMMARY

The identity of *Adiantum aethiopicum* L. in Southern Africa is established. Morphological characters, by which this species may be separated from similar species of Adiantum occurring in Southern Africa, are described and discussed. The known distribution of *A. aethiopicum* L. and *A. poiretii* Wikstr. in Southern Africa is given, and specimens examined by the author are cited.

FLOWERING PERIODICITY IN SOME WOODY PLANTS OF THE SOUTHERN BECHUANALAND PROTECTORATE.

O. B. Miller.

Though a good deal is probably known about the effects of climate in inducing, retarding and inhibiting flower production in cultivated plants, particularly orchard trees, but little seems to have been told us about these effects on wild-grown plants.

The time of flower, and consequently of fruit production, may have a considerable bearing on whether our savanna-woodlands are to survive. The degradation and, in places, the disappearance of indigenous woodland lessens its value as a means of slowing down wind velocity and thus helps to accelerate the rate of desiccation.

Survival of the woodland is dependent on natural regeneration. Regeneration in turn is dependent on protection against radiation, frost and fire. The time of flowering and fruiting must occur when conditions are most favourable. This factor will decide the future composition of the woodland and its effectiveness in reducing wind force. A year's observations on the flowering periods of a number of woody plants may therefore be of interest.

Again, close observation of flowering times may often assist the taxonomist in deciding whether or not to accord specific distinction to a plant which shows some minor difference or differences from the type specimen. It is suggested that where two or more plants differ only in some minor characteristics in flower or leaf, varietal rather than specific distinction is indicated if they are alike in general form and in time of flowering.

Table I gives rainfall and temperature figures at Kanye, a meteorological station 2½ miles distant from Pharing where the observations were made during the period 1st October 1947 to 30th September 1948. These records show the average temperatures and rainfall during 20 years and those of the year preceding and of the year during which observations were made.

The following is a brief description of the locality where the observations were made. Pharing lies at the bottom of the northern face of Kanye Hill. The hill is flat topped, about 4,500 feet above sea-level with a shallow, sandy soil overlying Waterberg conglomerate. The hill sides are steep, the northerly slope dropping down 500 feet into the Mokgodumo

TABLE I.

MONTH.	RAINFALL in inches.			TEMPERATURE in degrees Fahrenheit.					
	Average.	1946–1947	1947–1948	Average.		1946–1947		1947–1948	
				Max.	Min.	Max.	Min.	Max.	Min.
Oct. ..	0·97	2·78	1·00	84·5	58·4	83·2	58·1	84·5	60·4
Nov. ..	2·96	1·79	2·47	83·9	61·0	85·7	60·4	88·1	63·1
Dec. ..	3·14	4·86	2·07	85·0	63·1	87·3	64·2	84·9	62·6
Jan. ..	3·68	3·58	5·98	85·6	63·3	88·6	64·0	83·1	62·7
Feb. ..	3·00	1·10	0·55	82·8	62·4	90·8	62·5	83·5	62·5
March ..	2·83	3·64	3·40	79·9	60·0	82·4	58·0	78·8	61·5
April ..	1·38	0·14	3·01	76·0	54·2	79·5	57·2	76·2	52·1
May ..	0·67	0·09	0·27	71·1	48·3	73·2	47·4	72·7	48·0
June ..	0·24	—	—	66·0	42·6	68·8	41·5	69·3	42·3
July ..	0·03	0·06	—	66·1	42·1	65·7	38·4	69·9	44·6
Aug. ..	0·21	—	—	71·4	45·8	77·4	50·5	75·9	49·3
Sept. ..	0·34	1·22	0·03	78·3	51·5	78·3	53·0	80·4	61·3
	19·45	19·26	18·78						

valley of which the bottom lands are alluvial. To the north-west the conglomerate is displaced by a large mass of dolerite. The ridge across the valley is felsite from which is derived a poor soil of varying depth. Immediately north of Pharing is a large dam, fed by storm water, and below the dam a small irrigation scheme with granite koppies on the north and south. The whole area, except for the dam, the irrigation lands and some flat land in the valley is clothed with savanna-woodland.

The woodland has suffered to some extent by its proximity to the large Bechuana village of Kanye with a population of 20,000 inhabitants. Partial protection has however been in force for some years under tribal law. The composition of the woodland may be learnt by consulting Table III.

Table II gives the total number of species of plants found in flower during each month. During the year of observation the Wild Olive, *Olea africana*, the Wild Syringa, *Burkea africana* and the Tomboti, *Spirostachys africana*, all common trees here, did not flower at all. This fact was to some degree checked by keeping a careful watch for young fruits.

Mundulea sericea, *Securidaca longipedunculata* and *Cussonia paniculata* are scarce round Pharing; some of them fruited but unfortunately their times of flowering were missed. *Euclea undulata* and *Combretum transvaalense* are common shrubs and their flowering was also not observed.

It was a poor flowering season for *Acacia litakunensis*, *Acacia robusta*, *Gardenia spathulifolia*, *Mimusops zeyheri* and *Peltophorum africanum*.

It was in fact a poor flowering year generally in the Protectorate outside the observation area. Very few of the very common *Acacia dulcis* flowered. *Boscia rehmanniana*, so plentiful round Mochudi, did not flower at all, while in the extreme north the Rhodesian Teak, *Baikiaea plurijuga* and Bloodwood or Kiaart, *Pterocarpus angolensis* produced few or no flowers.

Where a species only provided a single specimen in flower, it was not included in Table II.

TABLE II.

Month.	No. of spp.	Month.	No. of spp.
194		1948	
Oct.	28	March	9
Nov.	19	April	12
Dec.	26	May	13
		June	15
1948		July	11
Jan.	21	Aug.	12
Feb.	20	Sept.	18

Table III is a list of all species found in flower with the months of flowering. Remarks are added to those whose flowering for any reason is noteworthy. To complete the picture, the species which did not flower at all are also given.

TABLE III.

Species.	Months of Flowering.	Remarks.
Acacia benthamii . .	Dec.—Jan.	
A burkei	Oct.	
A. caffra	Dec.—Jan. Aug.—Sept.	
A. detinens	Aug.—Sept.	1 plant had a few flrs in June—July. Heavy flrg on all trees in Aug.
A. giraffae	Aug.—Sept.	
A. karroo	Dec.—Jan.—Feb.	
A. litakunensis. . . .	Jan.	
A. stolonifera	Jan. Aug.—Sept.	
Acalypha glabrata *var.* pilosior.	Nov. — Dec. — Jan. — Feb.	1 plant in full flr May.
Antherothamnus rigida (*syn.* A. pearsonii).	Oct., Dec., June.	Oct. and Dec. flrgs heavy; June scanty.
Artemisia afra	Apl.	
Bauhinia macrantha . .	Nov.	
Becium angustifolium. .	May.	

Species.	Months of Flowering.	Remarks.
Blumea gariepina	July.	
Boscia albitrunca	Oct.	
Bridelia mollis	March.	A poor flrg year for this sp.
Burkea africana	—	Did not flr.
Canthium huillense	Nov.—Dec.	
Carissa bispinosa	Oct.	
Celtis kraussiana	Sept.	
Chrysophyllum magalismontanum.	Oct., Dec., Sept.	
Combretum apiculatum	Nov.	
C. transvaalense	—	Flrd, but not observed.
C. holosericeum	Oct., Sept.	
C. zeyheri	Oct.	
Corchorus pongolensis	Apl., June.	June flrs not fully developed. 1 plant with flrs in Aug.
Croton *spp.* (C. gratissimus and C. subgratissimus).	Oct., Jan.—Feb., Apl. —May—June.	Oct. the peak month with heavy flrg. Flr-buds formed in Dec., 1 or 2 flrs only on each raceme in the other months. Most buds (2—33 per raceme) dormant until Oct.
Cryptolepis oblongifolia	Dec.	
Dichrostachys glomerata	Dec., Feb.	In Feb. many plants had both flrs and fruits.
Dombeya rotundifolia	Aug.—Sept.	
Dyschoriste transvaalensis.	Oct.	
Ehretia hottentotica	Nov.—Dec.	
Elephantorrhiza burkei	Oct., Sept.	
Erythrina caffra	Aug.—Sept.	1 tree in June—July with flrs, flr-buds and leaves. All trees in flr in Aug., i.e. 1 wild and 6 garden plants. Tree indigenous but almost extinct.
Euclea undulata	—	A few plants flrd but not observed.
E. natalensis	May—June—July.	1 tree with heavy mass of flrs in May. Others all with sparse crops.
E. racemosa	Dec.	
Faurea saligna	Jan.	
Gardenia spathulifolia	Oct.	A poor flrg season. Only 1 tree seen with fruits.
Grewia avellana *Hiern.* (syn. G. calycina *N.E. Br.*)	Dec.	
G. flava	Oct. — Nov. — Dec. — Jan.—Feb.	
G. flavescens *Juss.* (includes G. retinervis *Burret*).	Dec. — Jan. — Feb. — March—Apl.—May.	
G. monticola	Dec.—Jan.	
Gymnosporia buxifolia	Oct., Feb., June—July.	1 tree in flr in Dec. Peak month Feb.
G. tenuispina	Nov.—Dec.	
Heeria salicina	Oct. — Nov. — Dec. — Jan.	2 trees with flrs in Jan.

Species.	Months of Flowering.	Remarks.
Hemizygia elliotii . .	Oct.	
Heteromorpha trifoliata	Feb.—March—Apl.	
Hibiscus micranthus . .	Oct., March, May—June	
H. subreniformis . .	Dec., May—June.	
Justicia odora	Jan. — Feb. — March — Apl. — May — June—July.	
Justicia *sp.*	June.	
Lachnopylis heterotricha	June — July — Aug. — Sept.	
Lantana salvifolia . .	June, Dec. — Jan. — Feb.	
Lasiosiphon polycephalus	July.	Heavy crop of flrs.
Lippia asperifolia . .	Oct., Jan — Feb. — March—Apl.—May.	
Lycium *sp.*	Apl.	
Maerua schinzii . .	Oct.—Nov.—Dec.	
Melhania acuminata . .	May.	
Mimusops zeyheri . .	Jan.—Feb.	
Ochna pretoriae . .	Oct.	
O. pulchra	Oct.	
Olea africana	—	A common tree. None flrd.
Osyris abyssinica . .	July—Aug.—Sept.	2 of the 3 known plants flowered.
Pappea capensis *var.* radlkoferi.	Jan.—Feb.	A poor flrg season.
Pavetta eylesii	Dec.	
P. zeyheri	Nov.—Dec.	
Peltophorum africanum	Dec.	A common tree and usually a prolific flowerer. 1 in flr in Nov. and 3 in Dec.
Plumbago zeylanica . .	Feb. — March — Apl. —May—June—July —Aug.—Sept.	
Pouzolzia hypoleuca . .	Nov. Jan.—Feb.	
Psiadia arabica . .	Oct. — Nov. — Dec. — Jan. — Feb.—March Apl. — May — June —July—Aug.	
Rhamnus zeyheri . .	Dec.	
Rhigozum brevispinosum	Dec.	
Rhus burchellii . .	Oct., Feb.	
R. gueinzii	Feb.	
R. lancea	May—June—July.	
R. magalismontanum . .	Nov., Sept.	2 clumps of plants flrd in Sept., possibly through a weak fire passing through them.
Royena sp.	Oct.	
Sclerocarya caffra . .	Nov.	
Scolopia mundtii ? . . (S. zeyheri ?)	Feb., Aug.	3 trees which flrd in Feb., 1948 flrd in July—Aug., 1944. 2 other trees flrd in Aug., 1948 and not in Feb., 1948.
Spirostachys africana . .	—	Did not flower.
Strychnos pungens . .	Dec.	

Species.	Months of Flowering.	Remarks.
Tapiphyllum parvifolium	Nov.	
Tarchonanthus camphoratus	Apl.—May.	
Turraea obtusifolia ..	Dec.—Jan.—Feb.	
Vangueria infausta ..	Oct., Sept.	
Vitex zeyheri	Nov.—Dec.	
Ximenia americana ..	Oct., Apl., June—July —Aug.—Sept.	Plants usually bearing a few flrs and many buds during June—Sept.
X. caffra	Oct., Sept.	An occasional flr among many buds in Sept.
Zizyphus mucronata ..	Nov., Jan. — Feb. — March.	A poor flrg season for this species.

BOOK REVIEW.

INTERNATIONAL RULES OF BOTANICAL NOMENCLATURE, compiled from various sources by W. H. Camp, H. W. Rickett, and C. A. Weatherby, Waltham, Mass.: The Chronica Botanica Co. Johannesburg: Central News Agency. 1948. $3.50. pp. 120.

That the names used for objects be uniform and always applicable to the same things is as important for a descriptive science as is a stable orthography to a language. Without this there is no real means of communication and no progress. Nomenclature is often regarded by collectors and amateurs as a necessary evil and any change in a name familiar to the individual is apt to be resented. But for any scientific progress a stable series of names each applying to a definite plant is essential. Without it there must be uncertainty and there is sure to be disagreement.

The attempt to achieve such stable names has been the aim of successive International Botanical Congresses for a long time. The basis of the present rules were laid at the Vienna Congress in 1905. Elaborations and modifications have been agreed upon since. The present volume is a statement of the outcome of these deliberations and gives the results as agreed upon in 1930 and the modifications suggested in 1935 which are due for ratification at the forthcoming Conference in 1950. As its editors are careful to point out this is not an "official" document. The latest official statement of the Rules, published in 1931, is now out-of-print. It has, however, been drawn up from official sources and in view of the forthcoming conference its appearance is both welcome and timely. The modifications to the Rules made in 1935 are for convenience of reference printed in heavier type. In this volume of 120 pages, the rules themselves with their accompanying explanatory notes occupy 30 pages, the remainder is taken up with appendices very much the largest of which is a list of names of genera which are conserved, *nomina generica conservanda*, and used although their adoption is not in strict conformity with the rules themselves. Along with this is a most useful index of the genera conserved and those rejected.

These *nomina conservanda* have for long been a source of some criticism and disagreement. Purists readily make out that their use is illogical and that their retention is a weakness in the rules by stultifying the principle of priority as laid down. Against these objections the principle is laid down (Art. 4) that names liable to cause confusion are to be avoided and the creation of unnecessary names to be discouraged. The list on *nomina conservanda* is made up of generic names which have been in general use for a long time, at least 50 years, and whose use is unambiguous. The replacement of these by the revival of forgotten and unused synonyms or in some cases by newly created names, would without doubt lead to a good deal of confusion.

Provided that the list is not extended too far and that cases based merely upon personal preferences are not admitted, the general convenience of retention of these names far outweighs any merely logical considerations.

The Rules themselves are divided into Principles, Rules, and Recommendations. The last are not absolutely binding. They are set out in four chapters dealing respectively with (1) General Principles, (2) Categories of Taxonomic Groups and their Names, (3), which is much the largest, Names of Taxonomic Groups, and (4) Interpretation and Modification of the Rules.

The bases of the rules are very simple, one name for one plant, the oldest valid name, usually starting from 1753, to be used, and the various categories, species, genus, family etc., to be based upon types. The type of a species is a definite specimen or in a few cases a pictorial representation, of a genus a species, of a family a genus, and so on.

This type system was agreed to internationally for the first time in 1930. Its adoption has brought about a number of changes in interpretation and definition. For present day descriptions it undoubtedly renders things much clearer and more definite. There are, however, difficulties in its retrospective application. In the case of many of the earlier described species there are no extant authentic specimens and it is necessary to select a type arbitrarily.

The type system has been much criticised on general scientific grounds. All the categories are really abstractions in the sense that they cover numbers of individuals which are not exactly alike. Older botanists undoubtedly drew up their descriptions to cover a range of such variations. To select one from such an assemblage as representing the species (or other category) is regarded as arbitrary. Against such arguments must be put the fact that the selection of a type renders a group, especially a species, quite definite and unambiguous, a most important advantage. Where a group is altered in connotation either by subdivision or by union with others, the name remains attached to that portion which contains the type. For example, the naming of parts of a genus which is subdivided, previous to the adoption of the type system was open to considerable disagreement but now the procedure to be adopted is quite definite. Further, the system ensures that no two names can be valid which are based on the same type: one must be a synonym.

Though essentially simple in plan, the application of the rules is in many cases difficult and can only be done after both historical and taxonomic study. Indeed finality can only be reached after consultation with the older collections and libraries most of which are in Europe. For S. Africa this is a difficulty that cannot be surmounted but one that has to be met. The names in common use here are largely those adopted in the Flora Capensis, a work which was published before the adoption of the present rules. Many of these are not in conformity with them. There have been in recent years a number of articles in this Journal on some of the many cases that must be dealt with before an internationally stable series of names can be established.

It is not possible in the space available to discuss the rules in detail but there are one or two minor points that may be mentioned. One which is almost certain to be brought up in 1950 is the orthography of specific epithets. In the Rules there is a recommendation (Rec. XLIII) that specific epithets be written with a small initial letter except where they are taken from the name of a person or are generic or vernacular names.

There is a movement, much favoured in America and recently supported by Kew, that all specific epithets have small initial letters. This would certainly be simple. We have all got used to small letters for geographic epithets and could probably soon become accustomed to such things as *Erica petiveri*, *Gladiolus bolusii*, etc. On the other hand the dropping of the initial capital for epithets which are generic names or are vernacular names may often obscure historical data and may result in apparent bad grammar. For example *Schinus molle* or *Lythrum hyssopifolia* written so are hardly a credit to botanical scholarship.

The section of the Rules dealing with the names for hybrids (Chap. III, § 6) is perhaps the least satisfactory, and scarcely comes into line with recent developments in genetics. It is one that needs consideration at the next conference.

This volume is one of convenient size, well bound and well printed. There are a few misprints but these are obvious slips and not such as to cause any confusion. It is a book that should be in the hands of all taxonomists. Certainly its careful perusal before the Congress to be held in 1950 would very much ease the labours of the section dealing with nomenclature. The thanks of botanists generally must be extended to the American Society of Plant Taxonomists and especially to the three editors for making this work available to the world.

R. S. Adamson.

JOURNAL

OF

SOUTH AFRICAN BOTANY

VOL. XV.

SPHAGNUM IN SOUTH AFRICA.

By S. GARSIDE.

(With Plates IX—X)

INTRODUCTION.

Although the genus Sphagnum is recognised at sight by all botanists, the determination of species is a more difficult matter. In South Africa, those who require specific names will naturally turn to Dr. T. R. Sim's work on the Bryophyta of South Africa,(8) but unfortunately, owing to errors and omissions in both the key and descriptions of Sphagnum, it is very unlikely that a correct determination will be made.

A study of his herbarium has shown that Dr. Sim treats only of those specimens which he had in his collection, and this has resulted in the relegation to a footnote of *S. Balfourianum* and *S. Marlothii*, and the splitting-up of *S. truncatum* sens. lat. into two species, *S. truncatum* Horns. and *S. Rehmannii* Warnst. emend. Sim., which are only growth-forms taken from a long interconnected series.

Dr. Sim also devotes much space to the names of Rehmann's exsiccata of South African Sphagnum, listed in (2), but this is of little or no value to the student who may not be able to see them.

The key to Sphagnum given by Dr. Sim is based on a division of the species into two groups of leaf forms, but that Dr. Sim himself found this difficult in practice is shown by his determination of *S. laceratum* (at that time not recorded for South Africa) as *S. capense* Horns.

His object was to simplify the subject for "those many botanists who wish in the first case to know the mosses of South Africa before they begin to search for slight varietal or form modifications, and wider grouping has consequently been here adopted" (8, p. 129), but as the fundamental distinctions between species are cell details, only to be seen with the microscope, his references to leaf shape in the key are not very helpful.

Too much stress is also laid on the presence or absence of pores in the hyaline cells, a feature now known to be for the most part epharmonic rather than specific.

Dr. Sim very properly reduced many of the described species to synonymy, making of sixteen species originally cited in his preliminary list(7) only six in the final work.(8)

Since Dr. Sim wrote, two species new for South Africa have been discovered, *S. fimbriatum* Wils. (3, p. 248 and 9, p. 19) and *S. laceratum* Warnst., recorded here for the first time. Much careful collecting has still to be done before a complete revision of the genus for South Africa can be attempted, and this paper must be regarded only as presenting some aspects of modern work on variation which should be of help to the student in the field, and as providing a revised key and notes for species determination.

RESORPTION PHENOMENA.

In most species of Sphagnum, a certain amount of resorption of cell-wall substance takes place in special groups of cells, leaving either thin places or actual gaps or perforations in the cell-walls.

In *S. Balfourianum*, for example, the outer cortical cells of the main-stem and lateral-branches each have a single circular aperture formed in this way (Fig. 1C). Resorption is also frequent in the stem-leaves of certain species, the entire outer and inner walls of the hyaline cells disappearing completely so that the leaf consists of an open network composed almost entirely of partition walls, *e.g. S. laceratum* (Fig. 5Sm) and *S. Pappeanum* (Fig. 4Sm).

Many species of Sphagnum lose the outer walls of all the cells which border the extreme margin of the branch-leaf, resulting in the formation of what is termed the "resorption-furrow" (Figs. 1Bt and 4Bt). The resorption-furrow is of great importance for taxonomic purposes as it is characteristic of two large sub-sections of the Warnstorf classification, sub-section Rigida (with *S. Pappeanum*) and sub-section Cymbifolia (with *S. Balfourianum*).

The furrow is readily observed by cutting very thin sections of a leafy lateral-branch, for which dry material may be used, the sections being afterwards expanded by mounting in water or in glycerine-jelly containing some stain. Care must be taken that the true edge of the leaf is examined and not the broken end of a section.

If the branch, when seen in surface view, appears to be bordered by a thin, delicate membrane (Figs. 1Bc and 4Bc), this indicates the presence of the resorption-furrow, and contrasts markedly with the margin of thickened and extremely elongated cells forming the distinct border which is usually present in leaves without the furrow (Figs. 5Bc and 6Bc). It is a curious fact that no mention is made of the resorption-furrow in most of the botanical text-books.

JUVENILE STATES.

The species identification of the juvenile states of Sphagnum presents considerable difficulties and the student of the genus will be well advised not to attempt it at first, until he has made himself familiar with mature plants showing clear differentiation into main-stem and lateral-branches. Indeed, Le Roy Andrews (4, p. 8) has remarked: "In the case of 'juvenile' or otherwise incomplete or abnormally developed specimens, the stem-leaves have sometimes led bryologists, including Warnstorf, to a misunderstanding of even the species involved."

Juvenile plants consist of a simple axis bearing leaves which are often very similar to those borne on the lateral-branches of mature plants, though they are usually larger. Aberg (1, p. 6) terms such states "subsimplex" (Pl. IX, Fig. 1). If the young plant has developed simple lateral-branches, it is "monocladous," and if further developed, with fascicles of two or three branches, it is "oligocladous" (Pl. IX, Figs. 2 and 3).

It is impossible at present to make a key to the juvenile states of the South African species, as only those of *S. truncatum* sens. lat. are known with certainty, though *S. panduraefolium* is suspected of being the juvenile state of *S. capense* Horns. The others await discovery. When found, juvenile states should be carefully collected, and the species of Sphagnum growing in the vicinity should be determined. It is important to note that growth may be arrested at one of the juvenile states, and the plants may continue to vegetate until large masses are formed. Warnstorf(10) has described some of these as species. In South Africa, *S. panduraefolium* may be such a case of arrested development, and the juvenile state of *S. truncatum* may persist and vegetate for a long period in aquatic habitats.

The phases of transition from the juvenile state to the mature state may also remain in an arrested condition. It is suggested (v. inf.) that *S. capense* Horns. may be one of these. Such arrested states usually have stem-leaves with a structure intermediate between the completely isophyllous leaves of juvenile states and the anisophyllous condition of mature plants, where the stem- and branch-leaves are usually very different, one of the main differences being that the stem-leaves show a reduction or total loss of fibres and a much greater degree of resorption, the hyaline cells often having large membrane gaps in their outer walls, or these walls may completely disappear.

VARIATION IN SPHAGNUM.

In 1911, a monographic account of the species of Sphagnum for the world was published by Warnstorf(10) containing descriptions of 342 species. Of recent years, some aspects of Warnstorf's work have been considerably modified, particularly as regards his species concept.

Indeed, Le Roy Andrews (4, p. 12), who examined Warnstorf's herbarium at Dahlem, Berlin, doubted that "any really critical student, even with a fairly liberal concept of species could make out more than a hundred species of Sphagnum." It seems that Warnstorf took little account of epharmonic forms, and described all these as species, and although his descriptions are excellent, later workers are of the opinion that many of his species must be reduced to synonymy.

It is necessary to have a long series of specimens before epharmonic variation can become obvious, and this Warnstorf certainly had not got for the South African species. An examination by the present writer of Sim's herbarium also shows that his series of forms was insufficient, and resulted in his separation of a sub-aquatic form of *S. truncatum* sens. lat. from the forms of drier habitats, which he called *S. Rehmannii* Warnst. emend. Sim.

The Sub-section Subsecundum of the genus Sphagnum, to which *S. truncatum* and *S. capense* belong, is one in which the species are now known to exhibit a very great range of variation in growth-form.

Aberg(1) has made a critical study of this group for the European species and has devised a somewhat complex series of descriptive terms for the growth-forms, which can, however, be directly and usefully applied to the South African species. The variations concerned in a single species may cover the relative crowding or sparseness of the lateral branches on the main axis, and their size, length and thickness, the degree of compactness or divergence of the leaves on the lateral-branches, and the direction and curvature of the branches themselves. Aberg's paper(1) should be consulted for the terminology of growth-form. Plate IX illustrates a full series of variations in growth-form for *S. truncatum* sens. lat.

Aberg has also devised a series of terms expressing the variability in frequency and distribution of the pores in the hyaline cells of the leaves.

In general, aquatic forms have larger leaves and pore formation is very much reduced. Many of Warnstorf's species (including some from South Africa) and some sections of his keys, are based upon differences in number of pores, and are consequently for the most part worthless. There is still much work to be done on epharmonic variation in the South African species, as the full range of growth-form for most of the species is still unknown, and hence the need for comprehensive collections, accompanied by careful notes on the conditions of the habitat, including light intensity and Ph value of the water supply. Fortunately, dried plants of Sphagnum keep their characters and can at any time be studied for variations in pore distribution. Little reference has been made to this subject in this paper, as it does not directly concern taxonomy, and those undertaking such a study should consult Aberg's work.(1)

For a simple demonstration of the effects of altered environment, it is usually possible to grow fresh Sphagnum, taken from a relatively dry habitat, in an aquarium or tank kept in a cool place for a month or six weeks.

FRUITING OF SPHAGNUM IN SOUTH AFRICA.

When Dr. Sim wrote his account of Sphagnum (8, p. 129) he reported that although archegonia and antheridia occur, capsules are not recorded, with the exception of a single capsule found by Warnstorf on one of the Rehmann exsiccata in the Berlin Herbarium.

Since this time, however, more fruiting stages have been collected, and whilst Sphagnum does not appear to fruit as readily in South Africa as it does in the northern hemisphere, fruits are probably more common than has been supposed; it is merely that so few collections of Sphagnum have been made. More recent records of fruiting are *S. fimbriatum* Wils. found at George.(3) said to be the first record of the species for South Africa, and claimed as "the first time that any species of Sphagnum has been found fruiting in South Africa." This material of *S. fimbriatum* is not in Dr. Sim's herbarium.

S. capense Horns. is recorded in a later paper(9) as fruiting in Diamond Stream, Kirstenbosch, Cape Peninsula, 29 November, 1929, with abundant capsules which were overtopped by leaves. Sim considered that this might be a specific character, but the specimen, which is in Dr. Sim's herbarium, No. 10301, proved to be *S. pycnocladulum*, so that this is the first record of this species in fruit. Plants of the same species were found fruiting at the top of Disa Gorge, Table Mountain, by Miss Walgate, February, 1947, and in these, the sporogonia were elevated above the perichaetial leaves on long pseudopodia, so that Dr. Sim's specimens No. 10301 were probably not fully developed.

SPHAGNUM AND SOUTH AFRICAN PALYNOLOGY.

A striking feature of recent work on pollen-analysis is the part played by Sphagnum peat in retaining pollen-grains carried by the wind from the surrounding vegetation to the Sphagnum swamps of former times.

In South Africa, there are no extensive Sphagnum swamps such as are found frequently in northern Europe and America, and only rarely do we find small marshes and pools on the mountain summits, where Sphagnum can grow. Stream-sides, rock fissures, and the so-called "flushes" on mountain slopes, where water issues from the ground, are the usual habitats, and as Dr. Sim remarks (8, p. 129) "the total quantity of Sphagnum in South Africa is extremely small."

The present writer has examined many South African collections of recent Sphagnum (not peat) and has noted a general absence of pollen grains of native species of plants. A few grains, apparently of Restionaceae, are all that have occurred, and it appears that air-borne pollen is decidedly uncommon in these Sphagnum tufts. On the other hand, pollen-grains of Pinus, frequently planted on Table Mountain, have been noticed from time to time in material from this locality.

THE TYPE SPECIMENS OF SOUTH AFRICAN SPHAGNUM.

The moss herbaria of Hornschuch, Laurer, V. F. Brotherus and C. Müller, as well as Warnstorf's Sphagnum herbarium were at Dahlem, Berlin. Warnstorf's herbarium, on which his "Sphagnologia Universalis" was based, contained 30,000 specimens, as well as numerous types. All these have been destroyed during the recent war, and it is much to be deplored that so few duplicates and co-types have found a resting place in South Africa, where they would be of the greatest value. Although the actual authors' types have been lost, there are in other herbaria many duplicates of the Drège plants and the exsiccata of Rehmann, on which several species are based.

Anyone who undertakes a critical revision of the South African Sphagnaceae will have to make use of these in lieu of type-specimens. The first two species of Sphagnum to be described from South Africa were *S. truncatum* Horns. and *S. capense* Horns., both from the collections of Drège.

THE PREPARATION AND EXAMINATION OF MATERIAL.

A remarkable feature of Sphagnum is the manner in which minute details of cell-wall structure are retained in dry or herbarium material, so that they can be accurately examined even after only a brief soaking in water. As the main sections of the key which follows are concerned with the characters of the cortical cells and of the cauline or stem-leaves, it is necessary to examine these very carefully. The Subgenus Inophloea, termed a subgenus in the new classification of Le Roy Andrews,(4) but called a section in Warnstorf's classification,(10) is characterised by the presence of fibres in the cortical cells of stem and branches, but occasionally these fibres may be very reduced or even absent in the stem-cortex, so that it is better to examine the branch-cortex for this character, where it can be readily observed after dissecting away a few branch-leaves. Spreading or erect branches are the best to use, taken from a vigorous plant showing good differentiation into main-axis and lateral fascicles of branches: if branching is not of this nature, a juvenile state is indicated.

For rapid work, stem-leaves can be detached from the dry material with fine forceps, and after dipping in spirit, to remove air, they are mounted in water for examination. This method is only recommended for use when the student has become familiar with the species and requires merely a few confirmatory details. A more thorough examination should be made by staining an entire plant, previously soaked in water, in a water-solution of genetian-violet. This requires a few seconds only, but the material does not overstain if left for a much longer period. Washing in tap-water follows, to remove all superfluous stain, and the material can then be placed in clean water in a dish, under the dissecting microscope, and the required parts removed with fine forceps, and examined in water or dilute glycerine. Permanent preparations are useful for reference, and can be made by mounting the stained parts in alkaline glycerine-jelly, made with:—

Davis (food) gelatine	5 gms.
Water	30 cc.
Glycerine	35 cc.
Undiluted T.C.P. (antiseptic) ..	5 cc.

The gelatine is dissolved in the water by heating, the glycerine added and finally the T.C.P. This gives a highly alkaline jelly which does not decolourize the genetian-violet, as will a jelly made in the usual way by the addition of phenol. The writer has found that the liquid sold as fishing-rod varnish can be used as an effective seal for ringing the slides.

Material can also be stained in bulk in gentian- or methyl-violet, and then re-dried and placed in the herbarium. In this condition it will be readily available at any time, and only requires soaking in water for immediate examination. The use of stained material is strongly recommended, as it greatly facilitates the observation of cell detail.

KEY TO THE SOUTH AFRICAN SPECIES OF SPHAGNUM.

1. Hyaline cells of the branch-cortex with fibres:—
Subgenus I. Inophloea Russ. 2
Hyaline cells of the branch-cortex without fibres:—
Subgenus II. Lithophloea Russ. 3

2. Hyaline cells of the branch-leaves with pores near the commissures only .. .. *Balfourianum*
Hyaline cells of the branch-leaves with commissural pores and also with 1—3, rarely 4—5 small superficial perforations .. .. .. *Marlothii*

3. Hyaline cells of the stem-leaves without fibres 4
Hyaline cells of the stem-leaves with fibres, either in the upper portion of the leaf only, or throughout 7

4. Stem-leaves spathulate (narrower at the base than above) the rounded apex finely fringed at the margin. Branch-cortex with retort-cells *fimbriatum*
Stem-leaves lingulate (tongue-shaped) or triangular or oval, apex rounded, entire or mucronate or dentate 5

5. Stem-leaves without pores in the hyaline cells 6
Stem-leaves with pores in the hyaline cells, especially in the upper half .. .. *pycnocladulum*

6. Stem-leaves shortly triangular, hyaline cells mostly not obliquely septate, extreme edge of branch-leaf bordered by a delicate membrane *Pappeanum*
Stem-leaves broadly lingulate, hyaline cells all obliquely septate, branch-leaves with a border of elongated, thick-walled cells .. .. *laceratum*

7. Branch-leaves almost uniform in size on a single branch, oval, deeply concave, apex pointed or minutely 2—5-dentate. Branch-cortex with retort-cells 8
Branch-leaves usually varying in size on a single branch, ovate-lanceolate to lanceolate, apex truncate, 2—12-dentate, rarely entire. Retort-cells none .. .. *truncatum*

8. Main stem and lateral branches not clearly differentiated. Stem- and branch-leaves similar, apex cucullate and entire or finely toothed, hyaline cells fibrous throughout the leaf and usually with pores *panduraefolium*
Main stem and lateral branches well differentiated, stem-leaves lingulate or oval, the hyaline cells with fibres and pores throughout the leaf, or fibrous in the upper part only, the lower hyaline-cells having only pores or membrane-gaps, or imperforate. Branch-leaves 2—5-dentate at apex .. .. *capense*

EXPLANATION OF THE LETTERING OF TEXT FIGURES. 1—8.

S.	Stem-leaf.
Su.	Stem-leaf cells from upper part of leaf.
Sm.	Stem-leaf cells from middle part of leaf.
Sl.	Stem-leaf cells from lower part of leaf.
B.	Branch-leaf.
Bc.	Cells of branch-leaf.
Ba.	Apex of branch-leaf.
Bt.	Section of branch-leaf.
C.	Cortex of branch-leaf, surface view.
T.	Cortex of stem, transverse section.

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NOTES ON THE SPECIES.

1. S. Balfourianum Warnst. in Hedwigia 30 (1891) 153.
Fig. 1 and Pl. X, No. 7.

A large, robust plant; pale-green when fresh, pale buff-coloured when dry; branch-leaves with cucullate apex, the margins inrolled and with a resorption-furrow (Fig. 1Bc and Bt). Stem-cortex 2—3, rarely 4 cells thick, with large perforations in the cell-walls of all the cells (Fig. 1T), its superficial cells with faint fibres and each cell with an external pore. Woody cylinder brown. Stem-leaves diverse in size (Fig. 1S, both upper and lower) the smaller triangular or spathulate and efibrose, the larger lingulate, fibrose in the upper half only, or throughout.

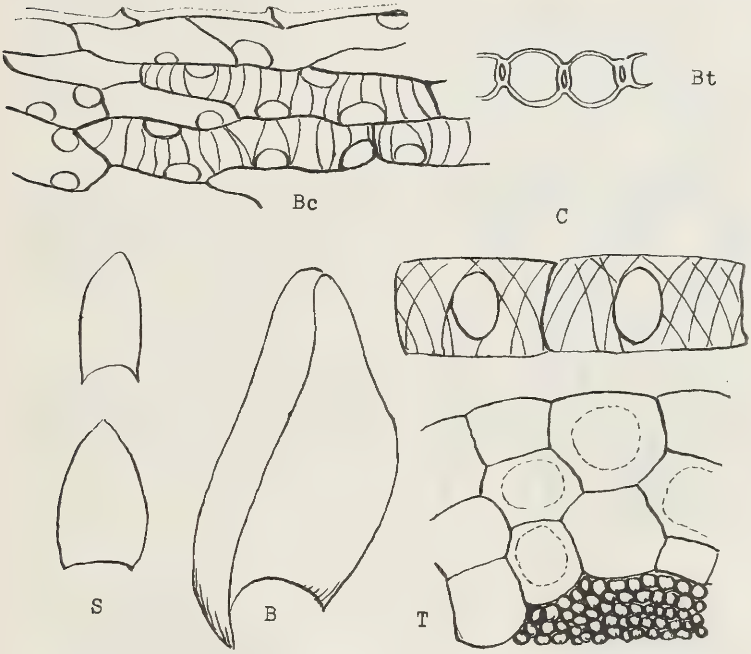

FIG. 1. *S. Balfourianum* Warnst. Drawn from *Pillans* 4280, south-west side of Groot Kop, Cape Peninsula.

Type from Mauritius, leg. Balfour; also in Madagascar. In South Africa known only from the Cape Peninsula: *Pillans* 4280; *Esterhuysen* 15839, but probably has a much wider distribution.

2. **S. Marlothii** Warnst. in Sphag. Univ. (1911) 471.

Probably not a good species, but merely a modification or growth-form of *S. Balfourianum*, with which it agrees in most features, but is distinguished by the minute pores in the hyaline cells in the upper portions of the branch-leaves.

Known only from the type collecting, Table Mountain, Cape Peninsula, 3346 ft., *Marloth*, in Herb. Dahlem.

3. **S. fimbriatum** Wils. in Hook. Fl. Antar. II (1847) 398.
Fig. 2.

Plants never red. Stem cortex 2—3-layered, superficial cells each with 1—3 large round pores. Wood pale greenish to yellowish, never red. Stem-leaves broadly spathulate, the upper half wider, its margins fringed by the disintegration of the hyaline cells. Branch-leaves ovate-lanceolate, up to 2 mm. long and 1.2 mm. wide, with a border of thickened cells: apex 5-dentate.

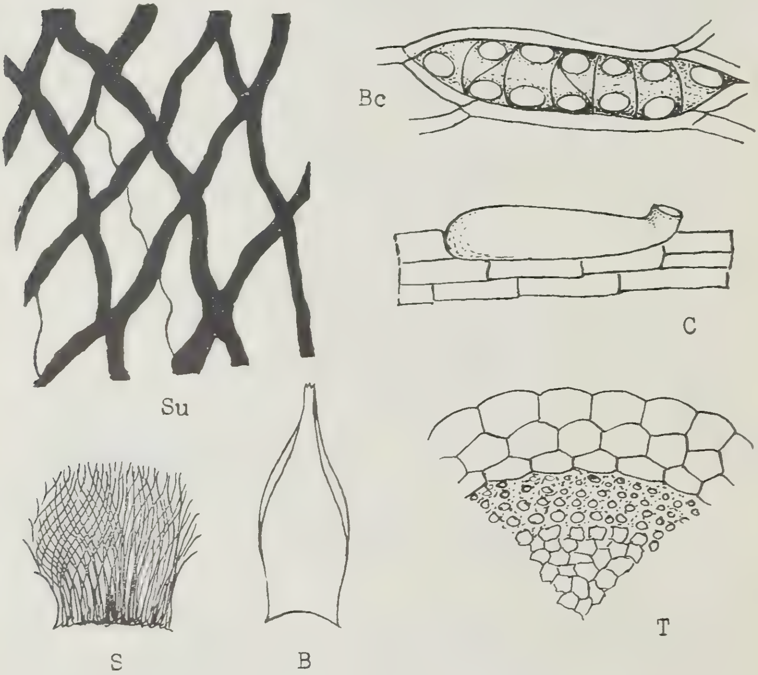

Fig. 2. *S. fimbriatum* Wils. Fig. S after Warnstorf, Sphag. Univ., Fig. 21A; the remainder from Braithwaite's "Sphagnaceae" (1878) Plate 16.

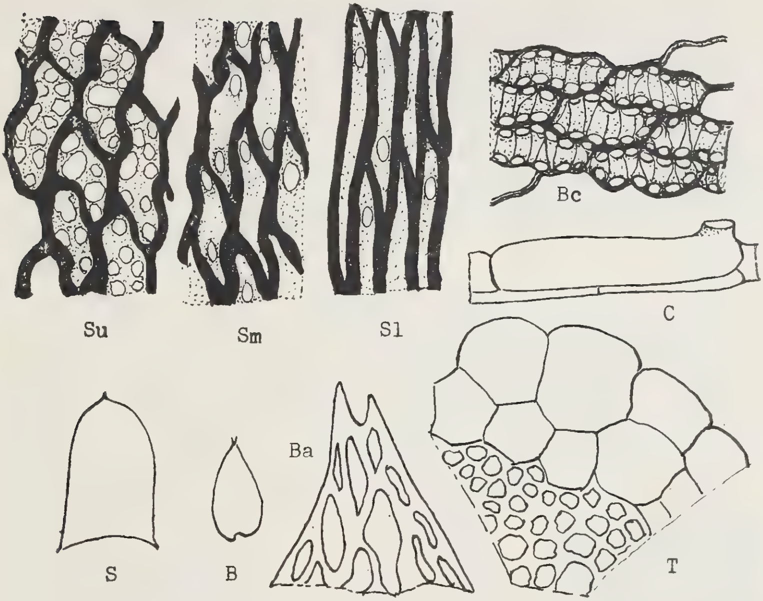

Fig. 3. *S. pycnocladulum* C.M. From *Rehmann* Ex., No. 17.

Widely distributed in the northern hemisphere in sub-arctic, temperate and Mediterranean regions, and in the southern hemisphere known from Chile, Patagonia and New Zealand. At present known from South Africa only from a single collecting at George, recorded by Dixon and Wager.(3) This material is not in Dr. Sim's Herbarium, and has not been seen by the present writer.

4. S. pycnocladulum C.M. in Flora (1887) 420.

Fig. 3 and Pl. X, Nos. 1, 2 and 3.

Stem-cortex of 2 layers of cells, the superficial cells each with a single pore or a thinner spot. Stem-leaves lingulate, apex rounded, mucronate (Fig. 3S), its hyaline cells efibrous throughout the leaf, the upper cells having numerous small, often irregular pores (Fig. 3Su) the more elongated middle and lower cells with one or two oval membrane-gaps (Fig. 3, Sm and Sl). Branch-leaves small, deeply concave, apex bifid (Fig. B and Ba), rarely entire, the hyaline cells with numerous fibres, and pores usually arranged in moniliform series along the commissures (Fig. 3Bc), sometimes with superficial pores. Retort-cells moderately developed (Fig. 3C).

Warnstorf distinguished two "varieties" of this species:—

var. *viride* Warnst. in Sphag. Univ. (1911) 176.

"Plants green above, robust, up to 20 cm. long."

var. *fuscescens* Warnst. loc. cit.

"Plants 10 cm. long, with dense dull subfuscous heads."

These are obviously nothing more than growth-forms, and can be neglected. Three frequent growth-forms are shown on Pl. X, Nos. 1, 2 and 3, No. 1 being dark-green, No. 2 fuscescent and No. 3 pale yellowish-white.

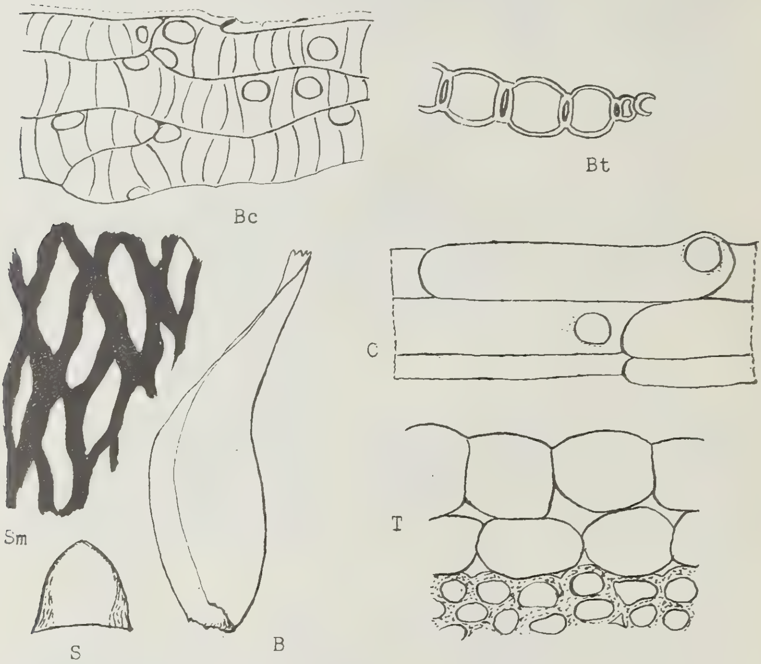

Fig. 4. *S. Pappeanum* C.M. From *Esterhuysen* 15049.

This species is known only from South Africa, where it appears to be widely distributed in the mountainous districts of the west.

Cape Peninsula, Window Gorge, Table Mountain, *Esterhuysen* 15362; Hex River Mts., Sanddrift Kloof, *Esterhuysen* 15427; River Sonderende Mts., *A. Wilman* 535.

See also remarks under *S. capense*.

5. S. Pappeanum C.M. in Syn. I (1849) 101.
Fig. 4 and Pl. X, No. 8.

This, when well-grown, is the most robust of all the South African species, but it occurs also in a stunted condition. Pale-green when fresh, white or grey when dry, with large branches bearing squarrose leaves. Branch-leaves with a resorption-furrow and a membranous edge (Fig. 4Bc and Bt).

Type from Swellendam, leg. *Pappe* in 1838. Known from the Isles of Amsterdam, Bourbon and Teneriffe; also in Central Africa, Ruwenzori. In South Africa it has been little collected so far, Hex River Mts., *Esterhuysen* 15049; Natal (in fruit), *Schelpe* 1704.

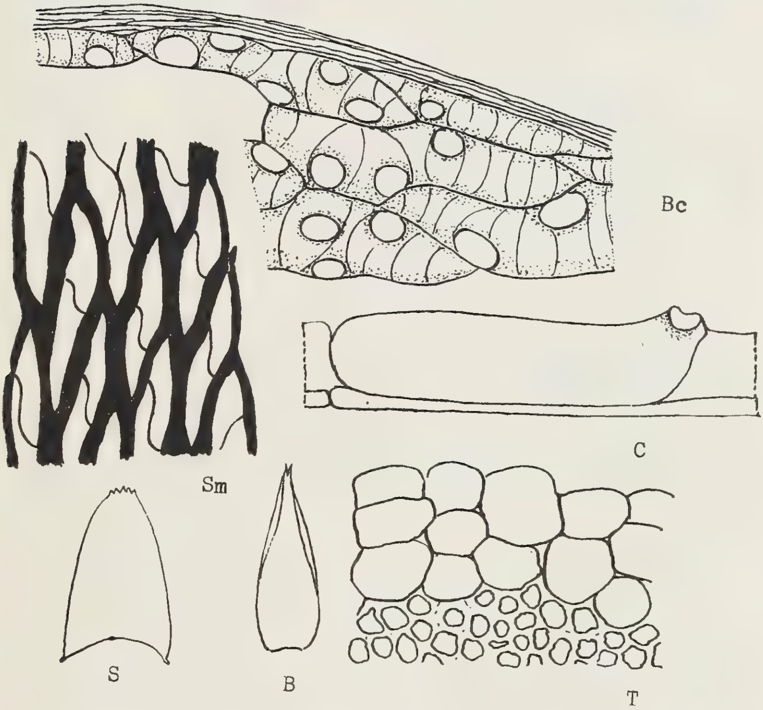

Fig. 5. *S. laceratum* Warnst. From *Stokoe* 9261, in Herb. Bolus., from River Sonderende Mts.

6. S. laceratum C.M. et Warnst. apud Warnst. in Hedwigia 36 (1897) 149.

Fig. 5 and Pl. X, No. 6.

This species is characterised by its pink or red colour, which extends even to the woody cylinder of the stem. Branch-leaves lanceolate, closely imbricate, and with few but very large pores, often placed in opposite pairs on the inner and outer walls of the hyaline cells. When stained with methyl-violet, the leaf appears to be pierced with numerous large holes. A very distinct species, previously known only from Brazil. Type, Minas Garaes, leg. *E. Ule* 1294. Recorded for South African from only two localities; River Sonderende Mts., *A. Wilman* 527; Riversdale, Garcias Pass *G. Thorne* (Nov. 1926, the first record), S.Af. Mus. Herb. 38817; and *Muir* (July, 1930), Dept. Agric. Herb. Crypt. 4138.

7. **S. truncatum** Horns. emend. Garside, including:—
S. truncatum Horns. in Linnaea XV (1841) 114.
S. Bordasii Besch. in Ann. Sci. Nat. Ser. 6, Vol. 10 (1880) 330.
S. coronatum C.M. in Flora (1887) 412.
 et var. *cuspidatum* Warnst. Sphag. Univ. (1911) 306.
S. oligodon C.M. in Flora (1887) 412,
 et var. *Bachmannii* Warnst. Sphag. Univ. (1911) 363,
 et var. *Beyrichii* Warnst. Sphag. Univ. (1911) 364.
S. marginatum Warnst. in Hedwigia 30 (1891) 28,
 et var. *diversifolium* Warnst. Sphag. Univ. (1911) 310,
 et var. *convolutum* Warnst. in Sphag. Univ. (1911) 309.
S. oxycladum Warnst. in Hedwigia 30 (1891) 15.
S. Rehmannii Warnst. in Hedwigia 30 (1891) 16.
S. transvaliense Warnst. in Hedwigia 30 (1891) 32.
S. eschowense Warnst. Sphag. Univ. (1911) 328.

Fig. 6 and Pl. IX, Nos. 1 to 9.

S. truncatum sens. lat. Hyaline cortex of one or two layers of cells, woody cylinder pale-yellow or fuscous. Stem-leaves broadly lingulate to elongated-lingulate, apex rarely obtuse and entire, more usually truncate and 3—12-dentate, narrowly to broadly bordered by 4—8 rows of narrow, elongated, pitted cells, hyaline cells elongate-vermiform, densely fibrous in the upper portion or throughout the leaf. Hyaline cells of stem-leaf simple, or with one oblique septum, or multiseptate (Fig. 6Sl, characteristic of *S. oligodon* C.M.), pores few, usually one at each end of the cell, or a few commissural pores, or none in some aquatic forms.

Branch-leaves usually broadest at the base of a branch, becoming narrower and longer towards its apex, ovate to lanceolate, apex truncate, 3—12-dentate, rarely entire; margin with a border of elongated cells 2—15 cells wide (Fig. 6Bc). Hyaline cells much elongated, vermiform or sinuous, pores various, as in stem-leaves.

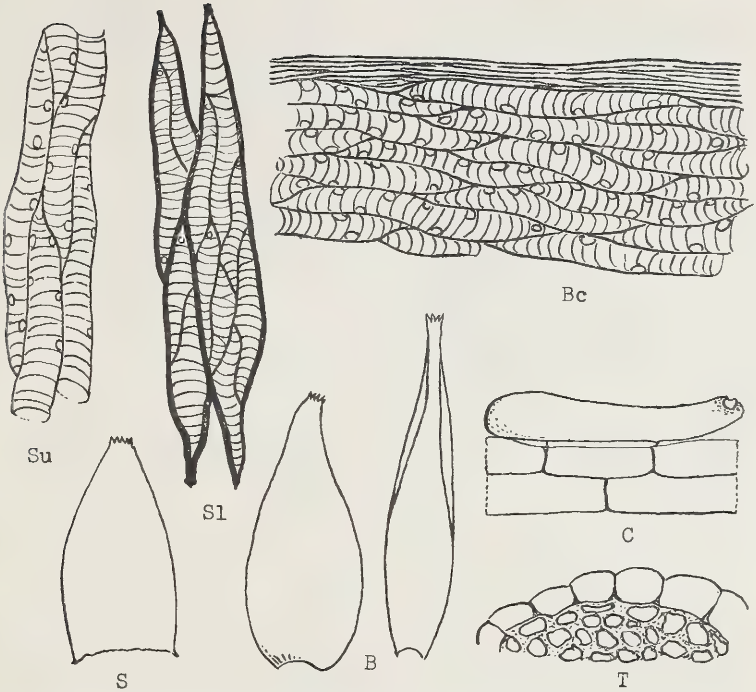

FIG. 6. *S. truncatum* Horns. emend. Garside. Sl. from *Rehmann* Ex. No. 14 (there named *S. oligodon* C.M.) from Inanda, Natal; the remainder from *Pillans* 9990, Cape Peninsula.

This species, which is found in a series of habitats, from aquatic to sub-terrestrial, exhibits a great range of growth-form, so that almost every specimen of it which reached Europe was given a distinct name, resulting in a long list of synonyms, but although both C. Müller and Warnstorf have left us excellent descriptions of the plants they examined, many intermediate forms can be found which are not covered by these. Le Roy Andrews (4, p. 4), speaking of Warnstorf's methods says: "In most cases, neither these long descriptions nor the involved keys furnished by Warnstorf contain actually specific descriptions. Any really critical student can hardly escape the impression that Warnstorf was not, in his later years, seriously trying to recognise species, but like Carl Müller, to make of almost every exotic specimen a species—" It will be convenient for the present therefore, to place all the "species" given in the synonymy at the head of this section under the oldest name, *S. truncatum* Horns. because the differences between the "species" are nothing more fundamental than variations in growth-form, and slight differences in cell-detail, probably correlated with external conditions.

S. truncatum Horns. is a marsh plant, collected by Drège from Du Toit's Kloof, where it has recently again been collected.

Dr. Sim regarded it as a distinct species, though his herbarium contains only one very poor specimen (leg. *Marloth* 147, from a pool at Muizenberg), a plant very similar to that on Pl. IX, No. 6.

As a result, he separated from it all the drier habitat forms with closely imbricated leaves, calling these *S. Rehmannii* Warnst. emend. Sim (6, p. 132), a name which seems to have been selected because of the distinctive growth-form associated with it. Broadly speaking, he attempted to separate the aquatic and sub-aquatic forms illustrated on Pl. IX, Nos. 4, 5 and 6, from the forms of drier habitat, Nos. 7, 8 and 9, but as numerous minor intermediate forms occur, or forms combining aquatic characters in the lower parts with characters associated with drier conditions in the upper parts, it is impossible to make such a distinction.

S. truncatum sens. lat. is probably the commonest and most variable species in South Africa, and has a wide range through the country where conditions are suitable, from the mountains of the Western Province to Natal. Fruiting specimens have never been found, and its mode of distribution presents an ecological problem of interest. Juvenile forms are frequent, and *S. eschowense* Warnst. from Zululand, known only from the type, seems to be one of these.

S. truncatum sens. lat. extends its geographical range to Madagascar; recorded as *S. Rehmannii* and *S. oxycladum* (5, p. 53).

8. S. panduraefolium C.M. in Flora (1887) 418 pp. et Warnst. in Hedwigia 30 (1891) 26.

Fig. 7 and Pl. X, No. 5.

Plants 2 to 8 cm. high, growing in thick tufts, stems simple or divided, but without true fascicle-branches, or rarely with these in fascicles of 2 or 3. Stem-leaves cucullate at the apex which is entire or minutely dentate; hyaline cells fibrous throughout the leaf, and with a few pores on both surfaces, especially near the apex. In the material figured here the pores are very numerous on the convex face (Fig. 7Sm, right-hand figure), and absent from the concave (inner) face of the leaf (Fig. 7Sm, left-hand figure). These are pore variations, a considerable range of which will probably be found. Warnstorf remarks (Hedwigia, 1891, p. 27): "Macht ganz den Eindruck einer noch nicht volkommen entwickelten Pflanze."

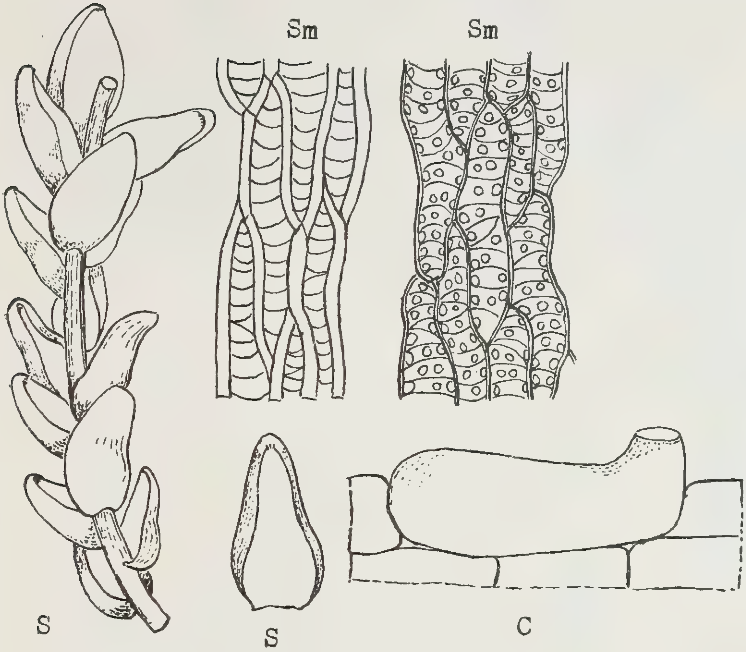

FIG. 7. *S. panduraefolium* C.M. From *Esterhuysen* 15560, Weenen, Natal.

The type was collected by *Rehmann*, Table Mountain, Cape Town, Nov. 1887. Its distribution in South Africa is not well known, as it has been very little collected. The material here figured is from Natal, Weenen Div., *Esterhuysen* 15560.

See also the remarks under *S. capense*.

9. S. capense Horns. emend. Garside, including:—
S. capense Horns. in Linnaea 15 (1841) 113,
  et var. *multiporosum* Warnst. Sphag. Univ. (1911) 428.
S. austro-molle C.M. in Flora (1887) 419.
S. mollissimum C.M. in Flora (1887) 418.
S. panduraefolium C.M. in Flora (1887) 418 pp. et Warnst. in Hedwigia 30 (1891) 26.
S. Beyrichianum Warnst. in Hedwigia 36 (1897) 157.
S. pycnocladulum C.M. in Flora (1887) 420,
  et var. *viride* Warnst. Sphag. Univ. (1911) 176,
  et var. *fuscescens* Warnst. Sphag. Univ. (1911) 176.

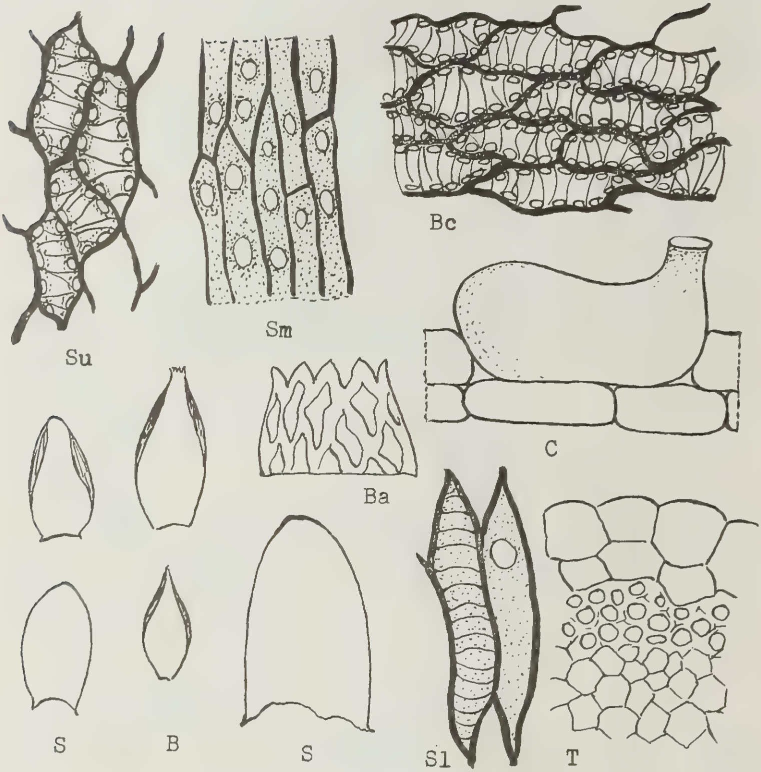

Fig. 8. *S. capense* Horns. S (large leaf), B (large leaf), Ba, Sl, and T, all from *Garside* 6184, Window Gorge, Table Mtn., Cape; the remainder from *Rehmann* Ex. No. 433c, Cape Town.

Plate IX. *Sphagnum truncatum* sens. lat.

Nos. 1—3. Juvenile states. *Esterhuysen* 15430, Table Mountain, below Corridor Buttress, in marsh.

Nos. 4—9. Growth-forms.

No. 4. *Esterhuysen* 15867, Sanddrift Kloof, Hex River, in running water.

No. 5. *Esterhuysen* 15442, Wynberg Reservoir, Table Mtn., Cape.

No. 6. *Esterhuysen* 15970, Marsh at top of Kasteels Poort, Table Mtn., Cape.

No. 7. *A. Wilman* 226. Bain's Kloof, Worcester.

No. 8. Herb. Bolus 24066, leg. Dr. *Levyns*, Mouth of Palmiet River.

No. 9. Herb. Bolus 24073, leg. Mrs. *Middleman*, Mountains between Bot River and Kleinmond.

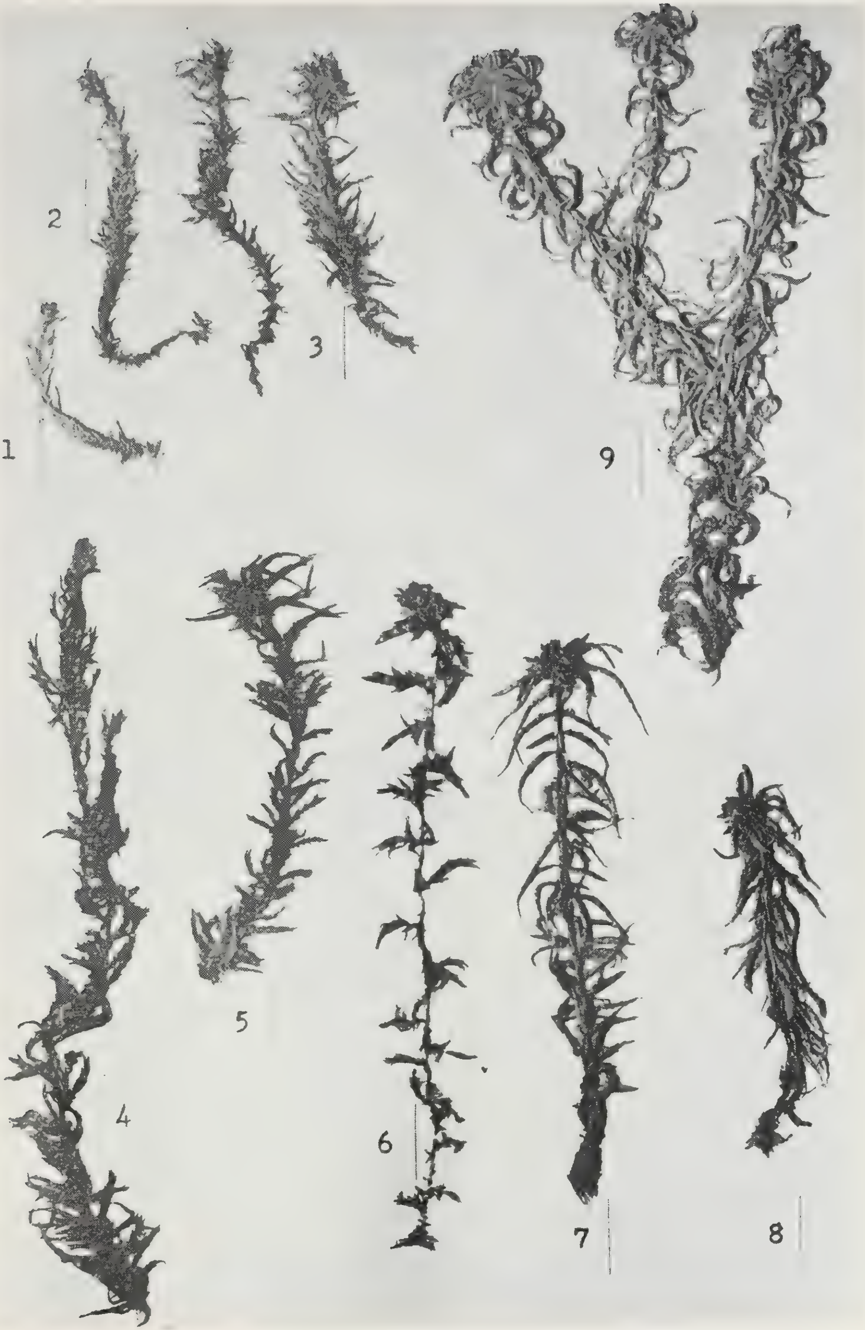

PLATE IX.

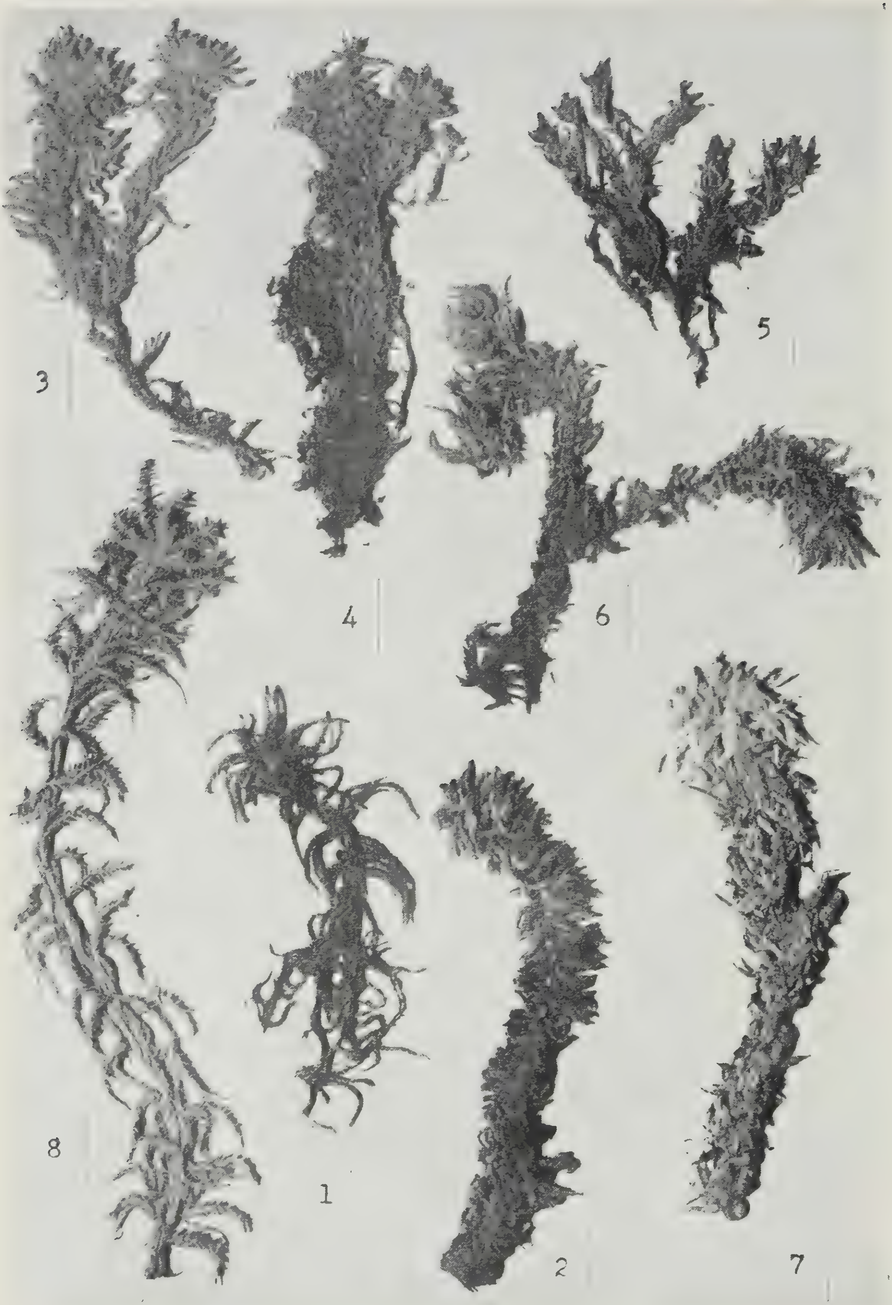

PLATE X.

Fig. 8 and Pl. X, No. 4.

S. panduraefolium C.M. is in all probability a juvenile state, as was suggested by both Warnstorf and Sim, and its leaf-structure indicates that it is probably a juvenile state of *C. capense*.

Moreover, plants can be found in which the lower leaves are cucullate, but the upper leaves show transitions to leaves identical with those of *S. capense*. *S. pycnocladulum*, which has now been found fruiting on two occasions, is obviously a mature state, as it has the stem-leaves well-differentiated from those of the branches.

The stem-leaves of *S. pycnocladulum* have no fibres in any of the hyaline cells, those of *S. capense* have fibres throughout, or in the upper part of the leaf only. This feature, apart from growth-form, is the main difference between the two species. A minor difference is the apex of the branch-leaf, which is typically bifid in *S. pycnocladulum*, has 3 to 5 teeth in *S. capense*. Unfortunately these differences are not completely constant, plants can be found showing all stages of disappearance of the fibres from the stem-leaves; and branch-leaves with two teeth associated with stem-leaves having fibres are found. The treatment suggested for the present is to consider *S. panduraefolium*, *S. capense* and *S. pycnocladulum* as successive stages or growth-forms, under the name *S. capense* sens. lat., as in many cases it is impossible to separate the species with certainty, though it would be well to label herbarium material with a more precise name (as given in the key) if the characters are definitely present. The plexus of species requires considerably more study, and more careful observations in the field should be made.

S. capense Horns. has not been found fruiting so far, it has always been *S. pycnocladulum* which has fruits, a fact which might indicate that *S. capense* Horns. is not a fully developed state.

S. capense Horns. is widely distributed throughout South Africa, and is usually found in the same districts as *S. pycnocladulum*, but that they are in fact the same species has still to be proved.

Plate X.

No. 1. *S. pycnocladulum* C.M. *Esterhuysen* 15427, Waterfall above Sanddrift Kloof, Hex River Mtns.

No. 2. *S. pycnocladulum* C.M. *A. Wilman* 535, River Sonderende Mtns.

No. 3. *S. pycnocladulum* C.M. *Esterhuysen* 15362, Top of Window Gorge, Table Mtn., near stream.

No. 4. *S. capense* Horns. *Esterhuysen* 15431, Blinkwater Ravine, Table Mtn., near stream.

No. 5. *S. panduraefolium* C.M. *Esterhuysen* 15560, Weenen, Drakensberg, Natal, on wet sandstone rocks.

No. 6. *S. laceratum* Warnst. *A. Wilman* 527, Olifants Kloof, foot of Middelberg River Sonderende Mtns.

No. 7. *S. Balfourianum* Warnst. *Esterhuysen* 15839, Steenberg, Table Mtn., Cape.

The author wishes to express his thanks to Dr. L. Bolus, Curator of the Bolus Herbarium, University of Cape Town, for facilities for work and for the use of the library and herbarium; also to Dr. R. A. Dyer, Chief of the Division of Botany, Department of Agriculture, Pretoria, for the loan of Dr. Sim's collection of Sphagnum, and to many energetic collectors, especially Miss E. Esterhuysen and Miss A. M. Wilman, who have provided a large number of specimens for study.

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THE FLORAL MORPHOLOGY OF SOME SOUTH AFRICAN MEMBERS OF POLYGALACEAE.

By Margaret R. Levyns.

Introduction.

The family Polygalaceae is well represented in the temperate zone of southern Africa, three of the genera being common constituents of the Cape flora. Of these Polygala has a wide distribution over most of the world while Muraltia and Mundia are endemic to South Africa. While engaged on a taxonomic survey of the South African Polygalaceae the writer was impressed by the fact that certain species belonging to Psilocladus, a sub-genus of Muraltia,(5) approached Polygala closely. Recently this fact has been emphasised by the discovery made by Miss E. Esterhuysen of a new species growing on high mountains in the western Cape Province. This species, which the writer proposes to name *Muraltia esterhuyseneae* in honour of its discoverer, resembles Polygala in its large inner sepals, in the subdivided crest on the keel and in its fruit. In fact it is so similar to Polygala, that when first discovered it was regarded as a new species of that genus. Research, however, has shown that despite its close approach to Polygala in external form of the flower and fruit it is nevertheless a true Muraltia. The results given in this paper make that quite clear. Furthermore a comparative study of the species of the sub-genus Psilocladus has shown that the new species is closely allied to *Muraltia crassifolia*, another species characteristic of high mountains in the western Cape Province. In separating Polygala from Muraltia the surest means of diagnosis lies in the stamens. Muraltia always has seven stamens whereas Polygala has eight. In Muraltia the filaments are united almost to the base of the anthers, whereas in Polygala they are free for a considerable distance. Lastly the anthers in Muraltia dehisce by a longitudinal slit while in Polygala dehiscence takes place through a large, oblique pore.

In the past Muraltia has frequently been credited with eight stamens and it is a matter of historical interest to discover how this mistake first arose. When in 1737 Linnaeus established the genus Heisteria for the species we now know as *Muraltia heisteria*, he stated quite correctly that it had seven stamens.(8) Shortly afterwards he must have felt uneasy about the rather unusual number seven for a few months later he described the same species in Hortus Cliffortianus(9) and corrected his earlier statement, saying that the number of stamens was usually eight but might occasionally be seven. Here we see the birth of a mistake which has persisted up to the present day. Evidently the number seven was so abnormal that its existence in a flower was regarded as highly improbable. Bergius when he described two species in 1767, erroneously attributed six stamens to one and eight to the other.(2) De Candolle(4) leaves the number of stamens an open question for under Muraltia the number of stamens is not mentioned. However by implication the number may be assumed to be eight for this was given as the number in the family as a whole and he did not alter it in the case of Muraltia. Harvey in the Flora Capensis(5), Bentham and Hooker in the Genera Plantarum(1) and Phillips in the Genera of South African Plants(13) all perpetuated the mistake made by Linnaeus in the 18th century. Marloth(11), whose statements were usually based on personal knowledge, stated the number to be mostly seven. In this he was followed in 1929 by the present writer(6) who felt that although all the species growing on the Cape Peninsula and examined by her had seven stamens, there must be some foundation for the number eight so unequivocally given by eminent authorities in the past. Thus the possibility of Muraltia having eight stamens in certain cases was allowed to linger on. Now having examined nearly all the species of Muraltia, it is possible to say with certainty that the number is always seven. The probability that the number is never more than seven is borne out by a study of the floral morphology, the results of which are given below.

The following species have been investigated: *Polygala myrtifolia*, *Polygala virgata*, *Muraltia heisteria*, *Muraltia saxicola*, *Muraltia trinervia*, *Muraltia flanagani*, *Muraltia esterhuyseneae* and *Mundia spinosa*.

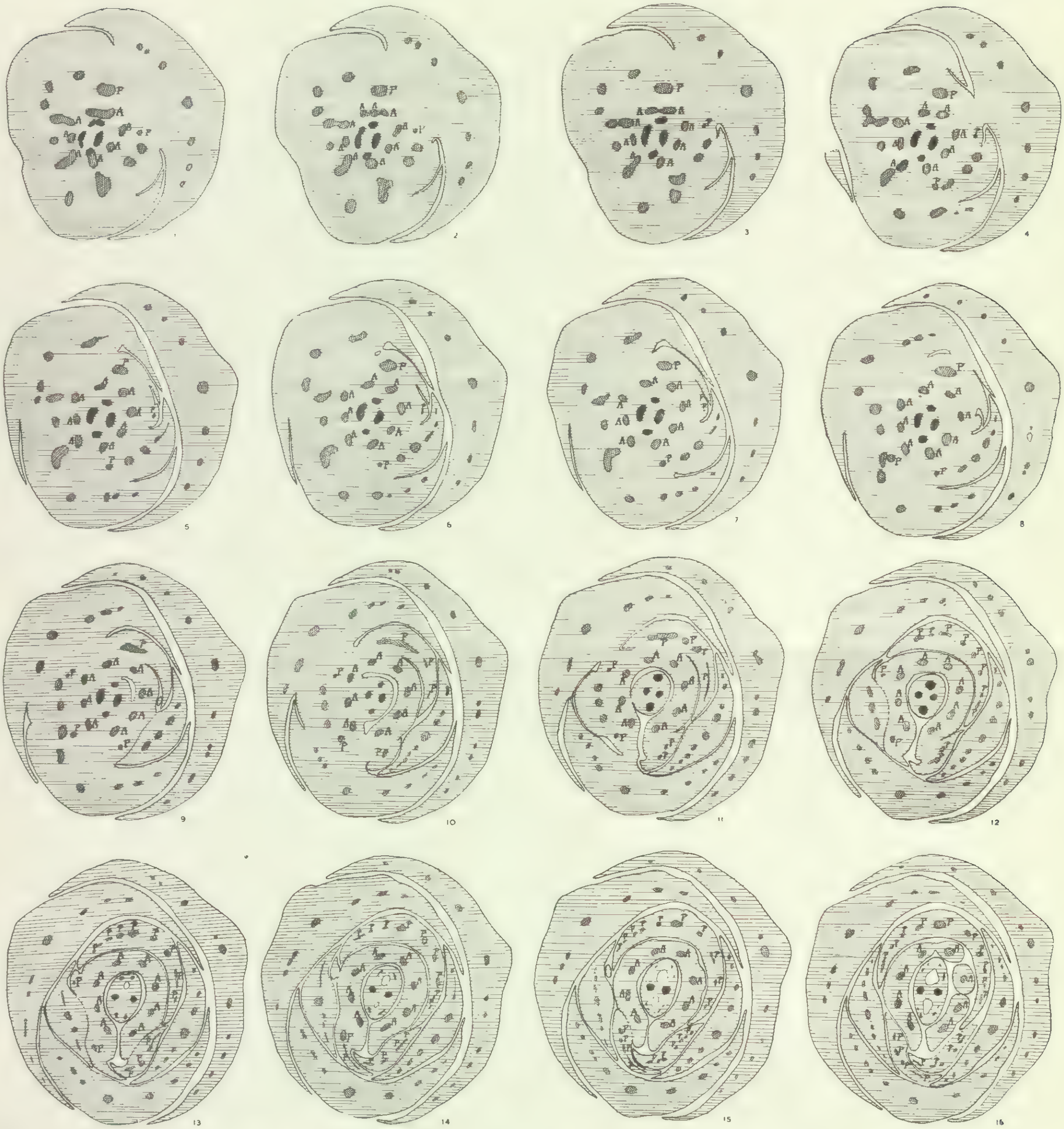
METHODS.

In all but *Muraltia esterhuyseneae*, living flower buds were fixed in formalin-acetic-alcohol. In *Muraltia esterhuyseneae* no fresh material was available, but in view of its importance dried flower buds were placed in boiling water until expanded and were then transferred to 70 per cent. alcohol. In all cases the buds were embedded in paraffin wax and serial sections cut, 12 μ in thickness. The sections were stained in Safranin and Fast Green.

All diagrams were made with the aid of a Leitz Panphot, the outlines, of the floral parts and their vascular strands being shown.

POLYGALA.

The structure of the flower in Polygala has been studied by several workers. Payer(12) showed that in very young flower buds of *P. speciosa*



Figs. 1—16. *Polygala myrtifolia.* Sections from the lower part of a flower bud. Vascular bundles are indicated by the more deeply shaded areas. Those which supply the gynoeceum are shown in black, while the remainder are cross-hatched. Those marked "A" supply the stamens. Those marked "P" supply the petals. The vascular bundles of the sepals are not lettered.

there were rudiments of five petals but that the two median lateral petals aborted at an early stage so that in the adult flower only three petals were evident. He also pointed out that in the outer whorl of stamens the stamen opposite the posterior sepal was missing, while in the inner whorl that opposite the keel did not develop.

These findings were supported later by Chodat(3) who stated that in most species the lateral petals remained rudimentary but that in *P. subuniflora* they were well developed and petaloid. He also mentioned that on rare occasions the missing stamens might develop.

The results obtained by the writer confirm those of the earlier workers who based their conclusions on developmental studies of very young flower buds in which the rudiments of the various floral parts were observed. In the present research a different method has been employed. Series of sections were cut through flower buds and by studying consecutive sections from the base of the flower upwards, it has been possible to determine the true floral nature of each part.

Polygala myrtifolia, on which the following account is based, was one of the species used by Chodat in his investigations. The writer has nothing essential to add to the account already given by Chodat(3) but for comparison with Muraltia, diagrams are given drawn from sections through the lower part of the flower bud showing the origin of the various floral parts and their vascular strands. The sections were cut at a slightly oblique angle to the longitudinal axis of the flower, consequently the organs on the right-hand side of the diagrams appear earlier in the sequence than those on the left. However, making allowance for this, the origin of all the parts is clearly shown. In Fig. 1 only two petal traces are evident. The upper and larger one supplies the keel. The other belongs to one of the lateral petals which abort. In this section a large vascular strand, destined to supply two of the stamens, lies immediately within the strand supplying the keel. Fig. 2, drawn from a section 24 μ higher up, shows the triple nature of the strand which therefore appears to be the potential vascular supply for three stamens. However, this appearance is lost almost immediately and two sections further on in the series (Fig. 3) two strands only are seen, just touching one another. Thus it is clear that the anterior stamen never develops and a very brief indication of its existence is all that is vouchsafed. In *P. myrtifolia* there is no indication at all of the posterior stamen. Fig. 4 shows the eight vascular strands belonging to the stamens, arranged in a ring round the strands of the gynoeceum. These strands may be traced through all the succeeding figures until in Fig. 16 the initiation of the separation of the individual filaments is seen. The vascular strand supplying the keel is apparent at a very early stage, but that belonging to the upper side petal becomes detached somewhat later. In Fig. 4 the latter may be seen, having just separated from one of the sepal traces. In this diagram the trace belonging to the abortive lateral petal is still visible and may be followed in Figs. 5, 6 and 7 as it passes into a small bulge which represents the rudimentary petal. In Figs. 8 and 9 the upper part of the petal may be seen after the disappearance of the vascular strand. A comparison of Figs. 4—14 will show the gradual separation of the lower right-hand petal from the staminal tube to which in its earliest stages it is completely united.

Similar behaviour of the various vascular strands on the left-hand side of the flower bud may be followed in Figs. 8—15.

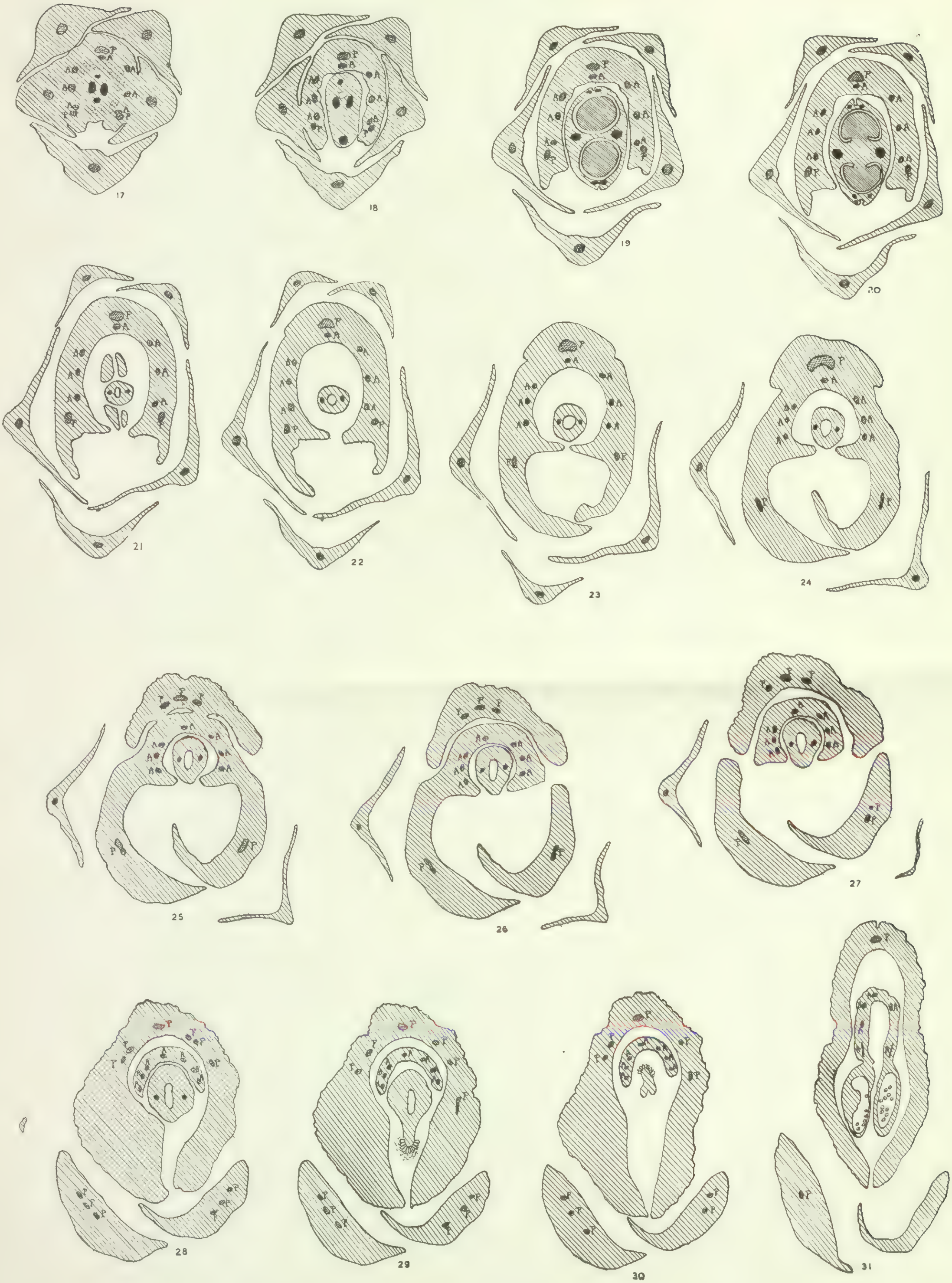
Polygala virgata is similar to *Polygala myrtifolia* in its essential features but a few differences may be observed. Rudimentary side petals are not developed though their vascular strands are clearly seen, arising just as in *Polygala myrtifolia* opposite a stamen of the inner whorl. In an abnormal flower bud which had only seven stamens, the missing stamen belongs to the inner whorl and is one normally lying immediately within a rudimentary petal. In spite of the fact that both the stamen and its vascular strand are missing, the trace belonging to the obsolete side petal is developed in the usual way.

Polygala virgata shows no evidence of any vascular supply to the stamen opposite the keel such as has been demonstrated for *Polygala myrtifolia*. However, here a well-defined patch of phloem lying opposite the posterior sepal, is clearly visible close to the base of the flower. It persists for only a short distance but its presence in this position suggests that it is a relic of a posterior stamen, a stamen which rarely develops in the family. A stamen in this position has been recorded by Chodat in an exceptional flower in another species.

A study of the vascular anatomy of the flower confirms Chodat's view that the flower of Polygala is essentially pentamerous and that the common numbers, three for the petals and eight for the stamens, have arisen by reduction.

MURALTIA.

Little work has been done on the floral structure of Muraltia but Chodat, in the course of his monumental researches on the Polygalaceae, examined very young flower buds in two species. He found that Muraltia was quite different from Polygala. He could find no evidence that side petals had ever existed in the genus. He also pointed out that abortion in the androeceum had proceeded along different lines from that in Polygala. He concluded that of the three missing stamens, one was the



Figs. 17—31. *Muraltia flanagani.* Sections of a flower bud, starting at the base and reaching the level of the anthers. The shading and symbols are the same as in *Polygala myrtifolia.*

posterior as in Polygala and the other two were those which should arise opposite the upper petals. This latter conclusion, as will be seen, is not supported by the present investigation.

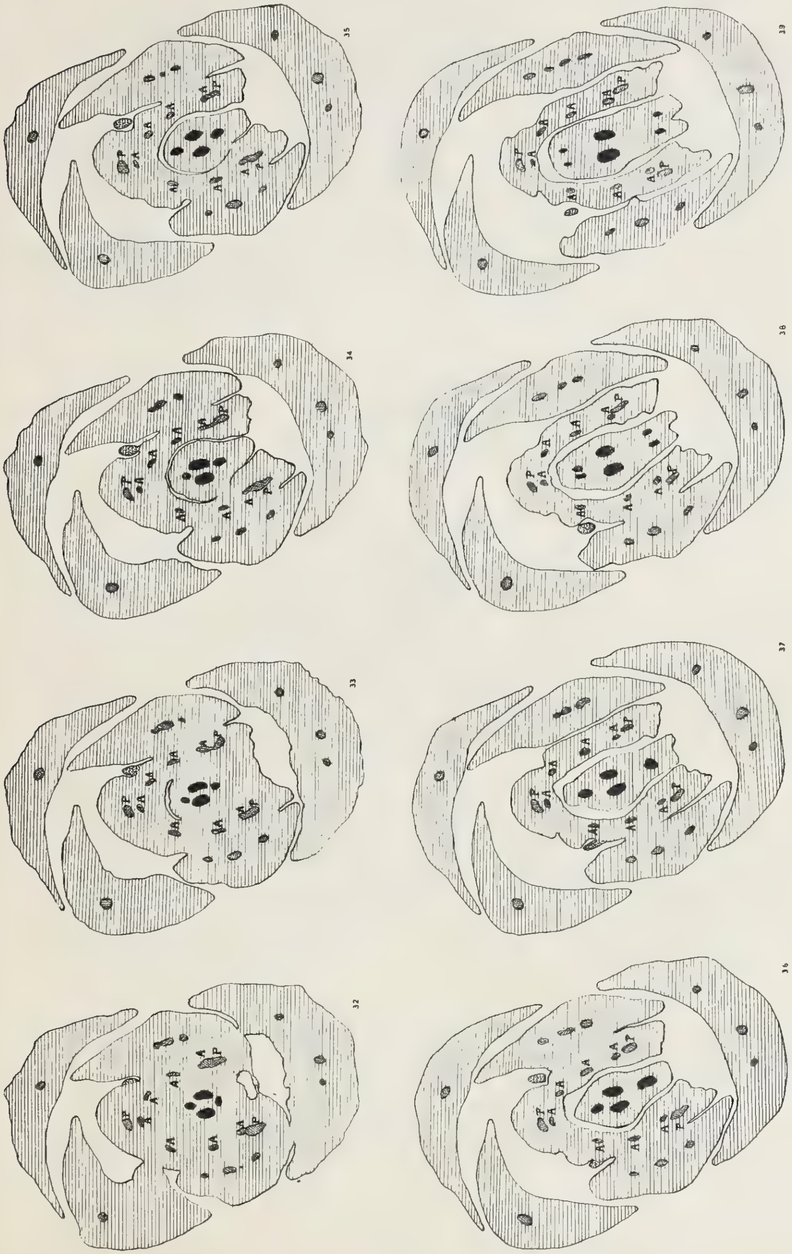
On taxonomic grounds the sub-genus Psilocladus is regarded as more primitive than the other sub-genus, Eumuraltia. During the early part of the investigation two species were studied: *Muraltia trinervia* (Psilocladus) and *Muraltia heisteria* (Eumuraltia). The floral morphology proved to be similar in both, there being no significant differences between them. The writer felt that if the genus had retained any primitive features, they would be found in some species of Psilocladus inhabiting the mountains. In a previous publication(7) the writer brought forward evidence to show that the mountains have provided sanctuary for the Cape flora at times in its past history when arid conditions threatened its existence. If this has been so then obviously the more primitive members are to be sought in these sanctuaries. Miss E. Esterhuysen who is a keen mountaineer as well as a botanist, kindly offered to obtain material from high altitudes and three of these alpine species have now been included in the investigation: *M. saxicola* (Eumuraltia), *M. flanagani* (Psilocladus) and *M. esterhuyseneae* (Psilocladus). *M. saxicola* and *M. flanagani* come from the upper slopes of the Drakensberg in Natal and *M. esterhuyseneae* from mountains in the western Cape Province. Of all the species studied the only one which was in any way unusual was *M. esterhuyseneae.* In the following account *M. flanagani* is taken as a typical example of the genus.

Fig. 17 is a section through the base of a flower when the vascular strands supplying all the floral parts are sharply differentiated. It will be noticed that even at this early stage the strands supplying the keel and the upper petals are clearly visible. The late development of the upper petals as seen in Polygala, is not a characteristic of Muraltia. The vascular strands supplying the stamens are clear and definite, and it is quite obvious that traces passing out into the two upper petals lie immediately outside the traces belonging to the two uppermost stamens. Thus Chodat was wrong in his supposition that two of the abortive stamens in Muraltia are those lying opposite the upper petals. Fig. 18 shows a section cut at a slightly higher level when the gynoeceum has separated from the tissue shaped like a horse-shoe and representing the fused stamens and petals. The section shown in Fig. 19 passes through the lower part of the ovary and shows differentiation of the upper petals. The next section (Fig. 20) is a little higher up, passing through the upper part of the ovary, and shows a slight increase in size of the side petals. In Fig. 21 the section passes through the four horn-like outgrowths on the top of the ovary, with the style passing up between them. In Fig. 22 the side petals are still larger and the first sign appears of the separation of the keel. This process is continued in Figs. 23—25. In Fig. 26 the keel and one of the side petals have become detached from the staminal tube. At this level only the two side sepals remain. Fig. 27 is similar but the other side petal has also become detached. Fig. 28 shows a marked increase in size and an alteration in shape of the keel, a feature connected with the pollination mechanism in Muraltia. Fig. 29 passes through the fertile stigma and Fig. 30, slightly higher up, shows a second stigma, in this species possibly non-receptive though stigmatic papillae are produced. In most species of Muraltia as in Polygala, only the posterior stigma is functional, but here and there, especially in the sub-genus Psilocladus, two apparently fertile stigmas are formed. Fig. 31 was drawn from a section passing through two anthers. Unlike Polygala the stamens have scarcely any free filaments, the anthers being almost sessile at the end of a staminal tube. The anthers bend upwards, almost at right angles to the staminal tube and as a consequence the anthers appear successively in longitudinal view in transverse sections of a flower bud.

Muraltia esterhuyseneae which, as has been pointed out, has several floral features suggestive of Polygala, has the floral structure of Muraltia with the exception that rudimentary petals are present. An examination of Figs. 32—39 shows this quite clearly. The general appearance of the vascular strands is much like that in *M. flanagani*, a small difference being that the vascular strands supplying the upper petals separate from the staminal traces at a slightly later stage (Fig. 36). The importance of *Muraltia esterhuyseneae* lies in the fact that rudimentary side petals are developed as in Polygala. These have no vascular strands and therefore must be regarded as more reduced than those in Polygala. Their position, however, shows us that the two lateral stamens which are missing in Muraltia, belong to the outer whorl and if present would lie opposite the two anterior sepals. It is therefore possible to construct a floral diagram for Muraltia, indicating the positions of the missing stamens (Fig. 40).

MUNDIA.

Mundia spinosa, the only species in the genus, has the same essential floral structure as Muraltia. The only noteworthy feature is that the two upper petals make their appearance at the base of the flower before the vascular strands which ultimately supply them have been organised. On taxonomic grounds Mundia is best regarded as a specialised off-shoot from the sub-genus Psilocladus of Muraltia. There is nothing in its floral morphology to oppose this view.



Figs. 32—39. *Muraltia esterhuyseneae.* Sections from the lower part of a flower-bud, showing rudimentary petals (stippled). The shading and symbols are the same as those used in Figs. 1—31.

GENERAL DISCUSSION.

The foregoing account makes it clear that Muraltia and Mundia are constructed on a different plan from Polygala. In Polygala one stamen is missing from each of the two whorls. In Muraltia the three missing stamens belong to the outer whorl and the inner whorl is complete. In spite of the Polygala-like appearance of *Muraltia esterhuyseneae*, there can be no doubt that it is a true Muraltia. In view of the fundamental difference in floral structure we are able to realise that the flower of Muraltia is most unlikely to have eight stamens and the attribution of this number to Muraltia in the past must have been founded on faulty observation. Once made, the mistake was perpetuated largely because it had the weight of authority behind it, and also because in dried material the number of anthers is not very easily observed.

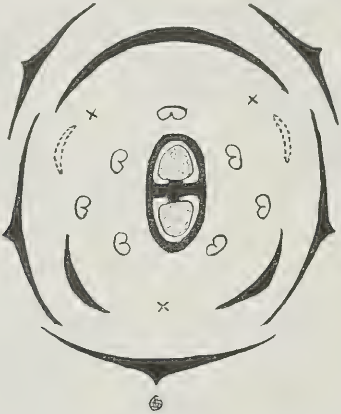


FIG. 40. Floral diagram of Muraltia. No attempt is made to show the cohesion and adnation of the various parts. The positions of the missing stamens are indicated by "×." The petals shown with broken lines are present in *M. esterhuyseneae* but in none of the other species. In a floral diagram it is customary to show the floral axis at the top of the diagram with the posterior parts of the flower lying immediately next it. In the present case the diagram has been turned through 180° so as to render comparison with the previous diagrams easier.

It is not possible to say which of the two genera, Polygala and Muraltia, is the more primitive. Both seem to have been derived from some common pentamerous ancestor but evolution has progressed along different lines. The almost complete suppression of the side petals in Muraltia suggests that in this respect it has departed further from the ancestral form. On the other hand the occurrence of a few species in which there are two similar stigmas, both apparently fertile, suggests that Muraltia has at times retained a primitive character in the gynoeceum, a character wholly lost in Polygala.

It is interesting to note that *Muraltia esterhuyseneae*, the most primitive known species of Muraltia, occurs on the mountains in the west. Weimarck(14) records the same phenomenon in Aristea and it is noteworthy that the only locality known for the primitive *Aristea singularis*, is not very far removed from the locality in which the most primitive species of Muraltia has been discovered. A full discussion of the significance of these facts must be postponed until taxonomic work in progress on Muraltia is complete.

SUMMARY.

1. In Polygala though only three petals develop, two more are present as rudiments. In Muraltia rudimentary petals have been seen in only one species. Mundia is closely related to Muraltia and lacks rudimentary petals.

2. Polygala has eight stamens, four belonging to the outer whorl and four to the inner. The missing stamens lie opposite the odd sepal and the odd petal. An exceptional flower with only seven stamens, was observed in *Polygala myrtifolia*. This, however, was due to the disappearance of one of the normal eight stamens and the position of the seven stamens was quite different from those of Muraltia. Muraltia and Mundia always have seven stamens, two in the outer whorl and five in the inner. A stamen is always found opposite the keel.

3. Polygala and Muraltia have probably evolved along rather different lines from some pentamerous ancestor.

ACKNOWLEDGMENT.

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ON SOME SPECIES OF *CENTELLA*—II.*

By R. S. Adamson.

Centella montana

Some plants which were collected recently on the Langeberg range between Garcia's and Tradouw Passes, run down in the Flora Capensis to *Hydrocotyle montana* but are very obviously different from plants so named collected in the Caledon region. These Langeberg plants are smaller and more tufted, and are covered with laxer, more spreading and more persistent hairs. The leaves are all alike, the basal not differing except in size, and they have shorter petioles, 1—3 cm. as compared with 3—7 cm. The blades are 3-veined, ovate-lanceolate, very acute, 0.7—1.2 cm. wide and 1.5—2.5 cm. long, more or less cuneate at the base, at the tip entire or with 3, less often 2 or 5, teeth of which the medial is longer than the others. The umbels are 3-rayed, with scarious narrow-lanceolate involucral bracts as long as the rays. The bisexual flower has obtuse glabrous petals which are as long as broad. The fruit is circular in outline or broader than long, glabrous and black when mature. The bracts are hairy, acuminate, as wide as and twice as long as the fruit. The mericarps are rather tumid, with 2 prominent and 2 faint ridges on each face and reticulate furrows.

The commoner plant in the south-west Cape is larger, more rigid, and has coriaceous glabrescent leaves. The basal leaves have spathulate-ovate blades, rounded at the base, either entire or with 3—5 almost equal teeth at the tip, and the upper leaves are ovate-lanceolate. The umbels are many-rayed, with an involucre shorter than the rays. The petals in the bisexual flowers are distinctly longer than wide and hairy along the middle line on the back. The fruit is pale-coloured and as long or longer than wide. The mericarps are flattened, each with 2 prominent ridges and smooth furrows. The bracts are about as long as the fruit.

It is evident that two distinct species have been associated under one name. Of the two, the Langeberg plants agree exactly with the original description by Chamisso and Schlechtendal (Linnaea 1.374.1826) of *Hydrocotyle montana*, and there is no doubt that they belong to that species. The type specimens (Mundt and Maire) were collected on the mountains of the Long Kloof, a locality not far distant. The other and apparently much commoner species, which is only recorded from the south-west coastal belt, agrees completely with Ecklon and Zeyher's description and specimens of *H. difformis* (Enum. 333.1837. *Zeyher* 2165).

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*For I see Journ. S. Afr. Bot., 6.49.1940.

When Sonder revised the genus for the Flora Capensis, he looked upon *H. montana* and *H. difformis* as synonymous. He adopted the former name but gave a description applicable to the latter only. All the specimens in his herbarium are of *H. difformis*.

Sonder's plan has been generally followed and the name *H. montana* has become associated with the western species. The only question as to the real identity of the two is in a remark by Domin in his monograph of *Centella* (Bot. Jahrb. 41.163.1908) to the effect that the description of *H. montana* by De Candolle (Prodr. 4.69.1830) is inaccurate and that Sonder's is better. De Candolle's description is obviously an abridgement of that of Chamisso and Schlechtendal. Though Sonder's usage has become current in herbaria it is not justified. The synonymy of the two species is:—

C. montana (Cham. & Schld.) Domin Bot. Jahrb. 41.162.1908.
H. montana Cham. & Schld. Linnaea 1.374.1826. (DC. Prodr. 4.67.1830.)

C. difformis (Eck. & Zeyh.) comb. nov.
H. difformis Eck. & Zeyh. Enum. 333.1837.
H. montana Sond. Fl. Cap. 2.531.1862. *Non* Cham. & Schld.

The following specimens which have been examined give a notion of the distribution:—

C. montana.

Uniondale Div.	Helpmakaar Mt. *Compton* 5192.
Swellendam Div.	Lemoenshoek Mt. *Walgate* 939; *Esterhuysen* 10442; *Adamson* 3880; Zuurbraak Mt. *Schlechter* 2103.

C. difformis.

Cape Div.	Muizenberg Plateau *Salter* 272/11, 1885; *Adamson* 3070.
Stellenbosch Div.	Hottentots Holland *Zeyher;* Somerset Sneeuwkop *Esterhuysen* 2596, 2597.
Caledon Div.	Genadendal *Ecklon & Zeyher* 2165 (type); *Burchell* 7672; Shaws Mt. *Lewis* in Herb. S.A. Mus. 53101; Hermanus *Salter* 5165; Onrust *Compton* 3963; Bot River *Adamson* 4099; Houwhoek *Schlechter* 7428; Elgin *Levyns* 3383; Kleinmond *Compton* 3962;

	Palmiet Riv. *Zeyher* 2666; *Bolus* 4139; *Levyns* 3837; *Compton* 12532; *Adamson* 4164, 4184, 4214; *Esterhuysen* 12613; Paardeberg *Adamson* 4188; Hangklip *Compton* 6107; *Adamson* 4225; Rooi Els *Leighton* 1450.
Bredasdorp Div.	Cape Agulhas *Salter* 4115; The Poort *Leighton* in Herb. Bolus 21091; *Esterhuysen* 3021.
Paarl Div.	Franschhoek Pass *Pillans* 7072.

CENTELLA RUPESTRIS.

Hydrocotyle rupestris was described by Ecklon and Zeyher (Enum. 334.1837) from specimens (*Zeyher* 2667, *Zeyher* s.n.) collected at the mouth of the Klein River. These specimens appear to be identical with those (*Schlechter* 9444) later described by Schlechter (Bot. Jahrb. 27.172.1900) as *H. arbuscula*, which were collected near Bot River. Schlechter's specimens are larger but not otherwise different. The descriptions agree in all essential features and there is no doubt the two are synonymous.

Sonder (Fl. Cap. 2.532.1862) regarded *H. rupestris* E. & Z. as a variety and included it in his rather comprehensive var. *coriacea* of *H. Centella*. Exactly the same course was followed by Domin in his monograph of *Centella* (Bot. Jahrb. 41.167.1908). This scheme was based on the fact that the plants distributed as *H. rupestris* E. & Z. by its authors were not all that species. In Sonder's herbarium the type collecting, *Zeyher* 2667, is not represented. There is a sheet labelled *H. rupestris* with the number *E. & Z.* 2170 which according to the ticket was collected at Swellendam. This is not identical with *Zeyher* 2667 but is a form of *C. glabrata* L. However, in the South African Museum there is a sheet with the same ticket, *E. & Z.* 2170, which is identical with *Zeyher* 2667. This sheet has in addition to the printed ticket one in manuscript recording the collection at Klein River. It is evident that confusion occurred in the application of the printed tickets.

Under *Centella* the species becomes:—

C. rupestris (E. & Z.) comb. nov.
H. rupestris Eck. & Zeyh. Enum. 334.1837.
H. arbuscula Schltr. Bot. Jahrb. 27.172.1900.
C. arbuscula Domin Bot. Jahrb. 41.168.1908.
H. Centella var. *coriacea* Sond. Fl. Cap. 2.532.1862 p. pte.
C. glabrata var. *coriacea* Domin Bot. Jahrb. 41.166.1908 p. pte.

OBSERVATIONS ON THE COLOUR INHERITANCE IN ROMULEA BULBOCODIOIDES.

By K. H. Schütte.

Introduction.

Colour variations occur in the flowers of many plants. Occasionally colour differences have been used to separate very similar plants into two species differing only in colour. Yet colour differences are often of a purely genetical nature and follow the ordinary Mendelian Laws of Inheritance. Where colouration is due to simple genetical factors, it is sometimes possible to observe this from ordinary field observations.

Very large numbers of the plant *Romulea bulbocodioides* occur on Rondebosch Common, Cape Town. This plant is of interest as its flowers occur in three colour varieties, having yellow, pale-yellow and white flowers. During the months of July and August, Romulea occurs in large masses, almost to the exclusion of other plants. This colony has been growing on the Common for much longer than thirty years.

As *R. bulbocodioides* is so well established and occurs in such great masses, it appears to be an eminently suitable plant on which to study the genetical behaviour of its colouring. Nothing is known of its genetical constitution and even its chromosome number is unknown. However, it probably possesses large numbers of chromosomes, as all the group of Iridaceae do. When studied, *R. bulbocodioides* showed only one mature open flower on each plant.

Methods.

The method employed to count the flowers was very simple. It consisted of counting all the flowers in a measured square meter. The flowers were divided into three types, yellow, pale and white flowers. At first sampling was entirely at random, but later special hybrid areas alone were investigated.

During the investigations, it was found that the pale flowers make an entire grade from yellow to white. This made sampling very difficult, so that it was eventually decided to distinguish only between yellow flowers and non-yellow flowers. These latter consisted of all the pale flowers and white flowers. The colours of the petals were measured in the usual way by comparison with Maerz and Paul's standard.(1) As it was only the top of the petals which showed this colour variation, only the tips of the petals were studied, not the entire petal.

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(1) Maerz, A. and Paul, M.R.: "A Dictionary of Colour," McGraw Hill Book Co., 1930.

EXPERIMENTAL.

The flowers were at first studied entirely at random, so that all possible combinations might be observed. The figures in Table I show a typical example of random sampling. All kind of combinations occur and there appears to be no relationship between these figures. Closer examination shows, that if the pale and the white flowers are counted together, about one-quarter of the counts approximate to the dihybrid ratio of 9 yellow : 7 other flowers. This is too high a percentage to be due to mere chance and so is worth investigating.

It is very difficult to distinguish between the various pale flowers and the white ones. This means that this is a source of error in the counts. These pale flowers occur in an entire grade from yellow to white but all shades do not occur in equal numbers. There are two pale types much commoner than the others; these are a pale yellow (Plate 9C, Maerz and Paul) and a cream-coloured type (Plate 9J).

The yellow colour is a lemon yellow (Plate 9D) and easy to distinguish from the other colours. Therefore, it was decided to distinguish between only two types of flower, the yellow ones and the non-yellow consisting of both pale and white flowers.

TABLE I.

Random Samples of Romulea bulbocodioides.
Number of Flowers per square metre.

Yellow.	Pale.	White.
*36	13	18
10	22	33
*17	10	8
9	5	17
18	15	15
33	13	26
35	18	22
*30	14	13
9	4	8
18	22	11
12	11	13

*Show the dihybrid ratio for the second generation, *i.e.* approximately 9 : 7.

Random sampling in the field yielded very little accurate information (Table I). Investigation showed that the flowers were not distributed homogenously. Patches of yellow flowers could be easily detected, as could patches of white ones. These areas were obviously regions in which true breeding types had separated out and were thus homozygous for colour. As the aim was to study the crossings of these two types, it was not desirable to include such areas in the samples taken.

When only areas which contain a good mixture of all colours were investigated, the figures obtained were very close to the dihybrid ratio for the second generation (Table II). It is remarkable how many do actually show this 9 : 7 ratio in the field. In all the areas examined, rather less than one-third did not show this ratio and many of these were situated very close to a true breeding area.

TABLE II.

Number of Flowers in One square metre in Hybrid Patches.

Yellow.	Pale and White.	Ratio.
36	31	$9 : 7\frac{7}{8}$
30	27	$9 : 8\frac{1}{5}$
15	13	$9 : 7\frac{1}{5}$
8	7	$9 : 7\frac{4}{5}$
* 9	9	$9 : 9$
*12	13	$9 : 9\frac{3}{4}$
15	13	$9 : 7\frac{4}{5}$
10	9	$9 : 8$
23	20	$9 : 7\frac{4}{5}$
*10	12	$9 : 10\frac{4}{5}$
17	15	$9 : 7\frac{9}{10}$
14	13	$9 : 8\frac{3}{10}$
31	22	$9 : 6\frac{2}{5}$
26	22	$9 : 7\frac{3}{5}$
*25	26	$9 : 9\frac{3}{10}$
23	20	$9 : 7\frac{4}{5}$
31	22	$9 : 6\frac{2}{5}$
15	13	$9 : 7\frac{4}{5}$
25	22	$9 : 7\frac{9}{10}$
17	15	$9 : 7\frac{9}{10}$

*Do not show dihybrid ratio.
Usually approximately one third of the samples do not show this ratio.

These results are unusual in that one would expect segregation of homozygous types to have occurred to a much larger extent in such an old and well-established colony. The only explanation can be that very intensive cross-pollination must occur in *R. bulbocodioides.*

CONCLUSIONS.

These investigations clearly show that yellow is the dominant colour and white the recessive in *R. bulbocodioides.* Dominance is not complete in heterozygous types, as these are pale-yellow or cream in colour. The other factor involved in this cross is almost certainly that for colour expression. This factor is also not completely dominant in the heterozygous state and this explains the occurrence of the various types of pale-yellow flowers. As the colours in these plants are so difficult to distinguish, this cannot be investigated in detail.

These plants appear to be well suited for genetical studies as colour is not the only characteristic that is inherited. The size of the plant also appears to be genetically determined. This factor was not investigated, although it was observed that both yellow and white plants were more frequently large in size than pale flowered ones.

SUMMARY.

Colour in *R. bulbocodioides* is genetically determined, the yellow and white types being homozygous, the pale-yellow types heterozygous. The plants were studied in the field and it was found that random sampling gave poor results, as this included homozygous colonies in the analysis. Only colonies showing a good mixture of both homo- and heterozygous types were investigated and these gave good results, as they show good crossing.

AFRIKAANS OPSOMMING.

Die kleur in die plantjie *Romulea bulbocodioides* is geneties vasgestel. Die geel en die wit blomme is die homozygotiese tipes. Die plantjies was in die veld studeer en dit is uitgevind dat die taal die plantjies van toevallig gevinde pleke, nie goeie resultate gee nie. Dit is omdat homozygotiese kolonies in die veld groei. Net goeie gemengte homo- en heterozygotiese kolonies moet studeer word om goeie resultate toe gee omdat hulle ware kleurkruising het.

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"Ex Africa semper aliquid novi."—*Pliny*

SERIES XXX

By R. H. Compton

(With Plate XI)

Cullumia stricta Compton. (Compositae—Arctotideae.)

Fruticulus glaber, dense intricate ramosus, perstante foliosus. *Folia* erecta, appressa, imbricata, rigida, linearia, infra unisulcata, apicibus pungentibus, marginibus aculeato-ciliatis. *Capitulum* solitarium, terminale, sessile. *Bracteae* interiores erectae, lanceolatae, apicibus pungentibus, marginibus eciliatis, scariosis. *Receptaculum* paleis laciniatis. *Flosculi radii* c. 8, ligulati, neutri, *disci* c. 8, tubulosi, hermaphroditi. *Achaenia* glabra, epapposa.

Hab. Cape Province. Montagu Division: Eendracht, 4,000 ft. alt., 23 Sept., 1946, *Compton* 18387 (*Type*, in Herb. Nat. Bot. Gardens). Laingsburg Division: Wittepoort, 3,000 ft. alt., 22 Sept., 1941, *Compton* 11841.

A densely and intricately branched shrub, the branches rigid, arcuate-ascending, covered with persistent leaves; glabrous throughout. *Leaves* erect, appressed, imbricate, rigid, linear, tapering to a pungent apex, with 4—5 forwardly directed stiff pungent cilia on each edge, unisulcate below, the midrib distinct above, 5—7 mm. long, 1.5 mm. wide at the base. *Capitulum* solitary, terminal, sessile, the leaves passing into the outer pectinate and so to the inner scarious bracts by transitional forms: innermost bracts erect, lanceolate, less rigid than the leaves, open-backed, with a pungent apex but no cilia, margins yellow, scarious,

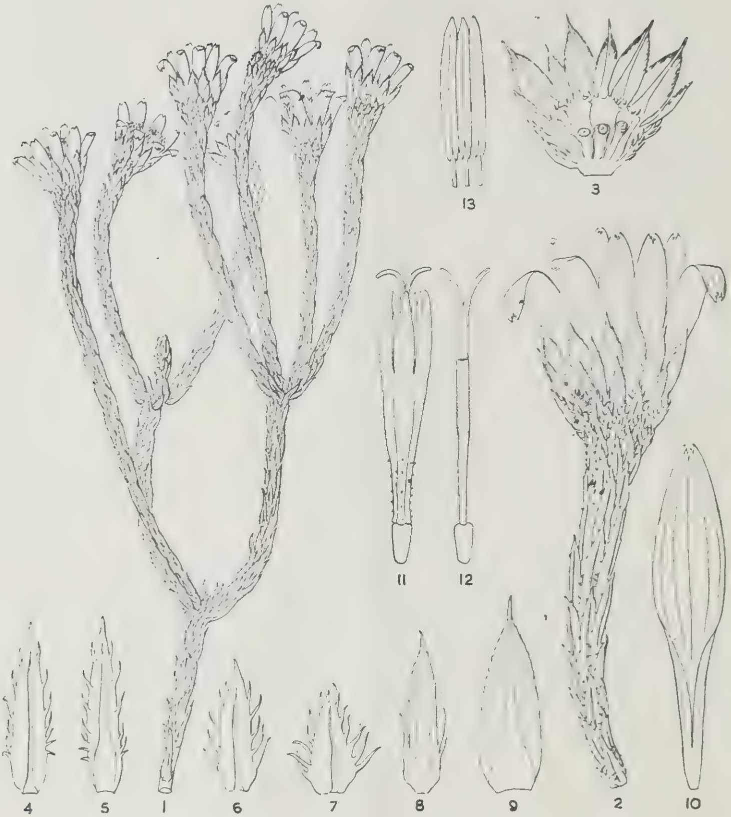


FIG. 1. *Cullumia stricta.* 1. Portion of plant nat. size. 2. Capitulum × 2. 3. Part of receptacle with fruits, scales and bracts × 2. 4. Leaf from below × 4. 5. Leaf from above × 4. 6. Leaf near capitulum × 4. 7. Leaf immediately below capitulum × 4. 8, 9. Bracts × 4. 10. Ray floret × 4. 11. Disc floret × 4. 12. Gynaecium × 4. 13. Part of androecium × 4. (*Compton* 18387.) *Del.* W. F. Barker.

finely serrate, 7—8 mm. long, 2·2 mm. wide. *Receptacle* bearing large laciniate paleae. *Florets* yellow, the outer c. 8, ligulate, neuter, the inner c. 8, tubular, hermaphrodite. *Achenes* glabrous without pappus.

A very distinct species, forming dense broad prickly bushes one or two feet in height on arid open hillsides. The two recorded localities are about 50 miles apart, and the plant may be expected to occur on the little known Wagenboomsbergen and Anysberg which intervene. Its nearest affinity is probably with *C. bisulca* Less.

Felicia ferulacea Compton. (Compositae-Astereae.)

Suffrutex laxus. *Rami* elongati, ferulacei, striatulati, sparse pilosi et glandulo-puberuli. *Folia* sparsa, plerumque alterna, basi erecta, supra expansa, saepe torquata, oblanceolata, utrinque scabrida, multipunctata, mesonevro infra prominente, marginibus ciliolatis, apice recurvata, mucronata. *Pedunculi* terminales et axillares, erecti, elongati, sparse bracteati, glandulo-puberuli. *Capitulum* solitarium, erectum. *Involucrum* multiseriatum, bracteis numerosis, angustis, convexis, acutis, scabridulis. *Flosculi radii* c. 18, feminei, ligulati, expansi: *disci* c. 65, hermaphroditi. *Achaenia* nigra, ovata, plana, marginata, glabra. *Pappi setae* paucae, barbellatae, caducae.

Hab. Cape Province. Ceres Division: Elands Kloof, 3,000 ft. alt., 29 September, 1944, *Compton* 16177 (*Type*, in Herb. Nat. Bot. Gardens), 3 October, 1940, *Compton* 9699; cultivated plants at Kirstenbosch; 2113/36, from same locality (farm Ebenezer). Clanwilliam Division: Uitkyk Pass, 3,200 ft. alt., 26 September, 1934, *Compton* 5104; Middleberg, Cederberg, 3,000 ft. alt., 28 September, 1937, *Compton* 7037; Elands Kloof, 26 September, 1936, *Lewis* in Herb. Bolus 22031; Elands Kloof, in a valley, 3 October, 1940, *Esterhuysen* 3283; South Cederbergen, ravine leading up to Sneeuwberg from Driehoek Valley, 2,000—3,000 ft. alt., 9 October, 1946, *Esterhuysen* 13103.

A loose straggling bush up to 2 m. high. *Branches* elongated, rod-like, purplish, striatulate, sparsely and shortly pilose and glandular-puberulous. *Leaves* scattered, mostly alternate, broad-based with decurrent margins, erect at base, spreading and often twisted above, oblanceolate, the midrib prominent on the lower and furrowed on the upper surface, apex recurved and mucronate, both surfaces scabrid or scaberulous, multipunctate, the margins with numerous forwardly directed ciliolae; up to 9 mm. long, 4 mm. wide. *Peduncles* terminal and axillary, erect, much elongated, 10—15 cm. long, with a few scattered leaf-like bracts diminishing in size upwards, glandular-puberulous. *Capitula* solitary, erect, c. 9 mm. long. *Involucre* multiseriate, of numerous narrow convex-backed acute bracts, the longest 6 mm. long, scabridulous. *Ray florets* c. 18, female, corolla ligulate, white or mauve, spreading, c. 7 mm. long. *Disc florets* c. 65, hermaphrodite, tubular, corolla yellow, 4 mm. long. *Achenes* black, ovate, flat, margined glabrous, 2·2 mm. long, 1·4 mm. wide. *Pappus* of few straight whitish barbellate caducous bristles, 3·5 mm. long.

This Felicia was first collected in 1934 in the Uitkyk Pass, Cederbergen, when it was regarded as perhaps a variety of *F. aethiopica* (Burm.). In 1936 it was found growing in swampy ground in the Cold Bokkeveld side of the old Elands Kloof Pass, near the farm Ebenezer, at about 3,000 ft. altitude: seeds were collected and grown at Kirstenbosch, the plant flowering in 1937 and subsequently. The same year, 1937, plants were collected on the Middleberg in the Cederbergen, also about 3,000 ft. altitude. Further material was obtained at the Elands Kloof locality in 1940 and again in 1944. It deserves separation from *F. aethiopica* (which has a very different area of distribution) on account of its lax growth, the mainly alternate position of its leaves, their recurved-mucronate apices and tendency to twisting, the mauve or white

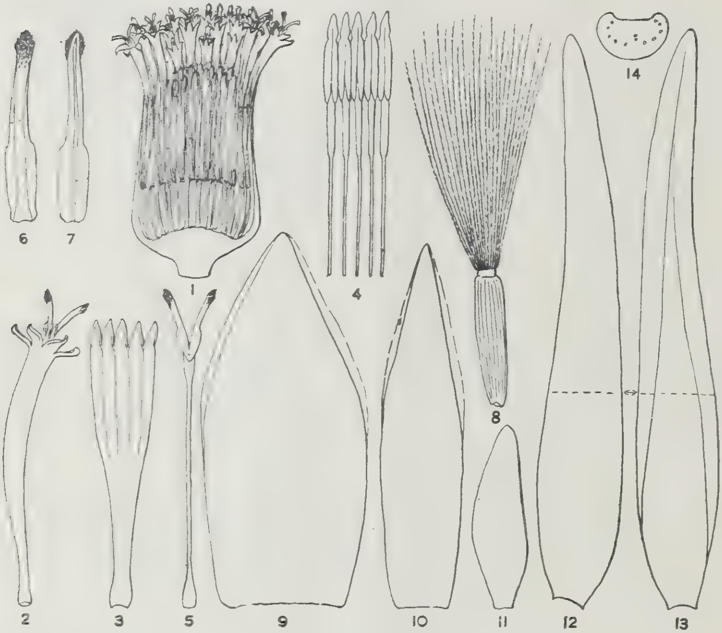


Fig. 2. *Kleinia cephalophora*. 1. Section of capitulum, nat. size. 2. Floret, with ovary and pappus removed × 2. 3. Corolla, laid out × 2. 4. Androecium, laid out × 4. 5. Style × 2. 6. Style branch, outer view × 4. 7. Style branch, inner view × 4. 8. Ovary and pappus × 2. 9, 10. Involucral bracts × 2. 11. Bract × 2. 12. Leaf from above, nat. size. 13. Leaf from below, nat. size. 14. Transverse section of leaf, position indicated by dotted lines, nat. size. (*Compton* 20678.) *Del.* W. F. Barker.

ray-florets which are rather more numerous, the convex-backed involucral bracts, etc. It keeps its distinctive characters well in cultivation.

Kleinia cephalophora Compton. (Compositae-Senecioneae.)

Fruticulus succulentus, glaber, glaucus. *Caules* nodosi. *Folia* erecto-patentia, elongato-fusiformia, acuta, marginibus crassis parum revolutis. *Pedunculus* simplex, terminalis, elongatus, bracteosus. *Capitulum* grande, solitarium, primo pendente, tamen erectum. *Involucrum* obconicum, basi truncatum, bracteis 8—13, herbaceis, acutis. *Receptaculum* planum. *Flosculi* numerosissimi, tubulosi, involucrum excedentes, flavi, albescentes. *Achaenia* glabra, fusiformia, striata. *Pappus* albus, setis numerosis, barbellatis.

Hab. Cape Province. Namaqualand: near Buffels River, 50 miles south-west of Springbok, 6 September, 1945, *Compton* 17270; same locality, 23 July, 1948, *Compton* 20678 (*Type*, in Herb. Nat. Bot. Gardens), and cultivated at Kirstenbosch (1657/48) where it flowered in July 1949: Schoerfontein (Richtersveld), 21 July, 1948, *Compton* 20656.

A small succulent evergreen shrub, glabrous and glaucous throughout, with numerous branches and basal shoots which are decumbent at the base becoming erect. *Stems* firmly fleshy, 2—3 cm. or more in diameter, terete with protuberant old leaf bases. *Leaves* erecto-patent, elongated-fusiform, widest about the middle, 6—10 cm. long, 1 cm. wide, 6 mm. thick, the fleshy margins slightly recurved partly covering a sunken ventral stripe. *Peduncle* terminal, erect, unbranched, up to 25 cm. long, terete, smooth, reddish, bearing several loose flat semi-succulent reddish ligulate bracts, the uppermost of which loosely surround the involucre. *Capitulum* pendulous in the bud, later erect, up to 4 cm. long and 4 cm. in diameter. *Involucre* obconic, truncate at the base. up to 28 cm. long, bracts 8—13, united half way up, the free portions ovate, erect, herbaceous with very narrow overlapping scarious margins, acute. *Receptacle* flat, naked. *Florets* very numerous, all tubular, hermaphrodite, fertile, much exceeding the involucre. *Corolla* yellow, tube c, 20 mm. long, gradually widening upwards, lobes 3 mm. long, spreading. *Style branches* c. 6 mm. long, tipped with a bristly cone and hispidulous below the apex. *Anthers* with exserted acute apices. *Achenes* glabrous, fusiform, striate, 15 mm. long, 2 mm. diam. *Pappus* of copious white erect straight barbellate hairs, 18 mm. long.

I first noticed and collected this plant in September, 1945, in the fruiting condition. An opportunity of collecting it in flower did not occur until three years later when I revisited the locality with Mr. G. W. Reynolds: on that expedition I also collected it in the Richtersveld, much to my surprise.

The general appearance of the plant resembles that of some Cotyledon spp. It is strikingly distinct from all other Kleinias and the solitary pedunculate capitula are of quite exceptional size.

I am indebted to Mr. Reynolds for the photograph (Plate XI) taken in the type locality on 23 July, 1948: Mr. Reynolds also made a colour transparency at the same time, and this is preserved in the National Botanic Gardens Herbarium. Living plants were also obtained and these flowered at Kirstenbosch in 1949.

Metalasia virgata Compton. (Compositae-Inuleae.)

Fruticulus virgatus, ramosus. *Rami* erecti, angusti, juventute lanati. *Folia* multa, erecta vel sub-appressa, haud imbricata, sessilia, coriacea, integra, ovata, naviculaeformia, apiculata vel sub-pungentia, supra albo-lanata, infra juventute pilosa, mox glabrescentia. *Capitula* pauca ad apices ramorum, haud pedunculata, obconico-campanulata. *Involucrum* multiseriatum, bracteis imbricatis, exterioribus lanceolatis, pilis lanatis intertextis, interioribus albis vel roseis, apicibus expansis, acuminatis. *Flosculi* 30—40. *Achaenia* glabra, pappi setis numerosissimis, tenuibus, purpureis, corollas excedentibus, conspicuis.

Hab. Cape Province. Bredasdorp Division: Strandkloof, sandy ground over limestone towards sea, 25 January, 1948, *Compton* 20459 (*Type*, in Herb. Nat. Bot. Gardens); 17 April, 1950, *Compton* 21937: hills near Elim, 22 April, 1897, *Schlechter* 10475.

A small erect virgate much-branched shrub up to 50 cm. high. *Branches* erect, slender, terete, lanate when young, not gemmuliferous. *Leaves* numerous, alternate, erect, erecto-patent or sub-appressed, almost covering the stems but scarcely imbricate, sessile, coriaceous, entire, ovate, boat-shaped, apiculate or sub-pungent, nerveless, the upper surface persistently white-lanate, concave, the lower surface pilose when young, soon glabrescent, up to 4 mm. long and 2 mm. wide. *Capitula* solitary or in groups up to 4 at the tips of the branches, scarcely pedunculate, obconic-campanulate, up to 10 mm. long, 5 mm. diam. at the middle. *Involucre* multiseriate, bracts imbricate, the outermost lanceolate, matted together with woolly hairs, with short scarious apiculae, grading into the innermost which have elongated white or pink spreading acuminate points. *Florets* 30—40, tubular, perfect, the corolla c. 4 mm. long, the narrow lobes almost as long as the tube. *Achene* glabrous, the pappus hairs very numerous, slender, smooth, tapering to very fine points, purple, exceeding the corolla and conspicuous at the mouth of the capitulum.

This species belongs to the small sub-genus Erythropogon, being most closely related to *M. imbricata* Harv., from which, however, it

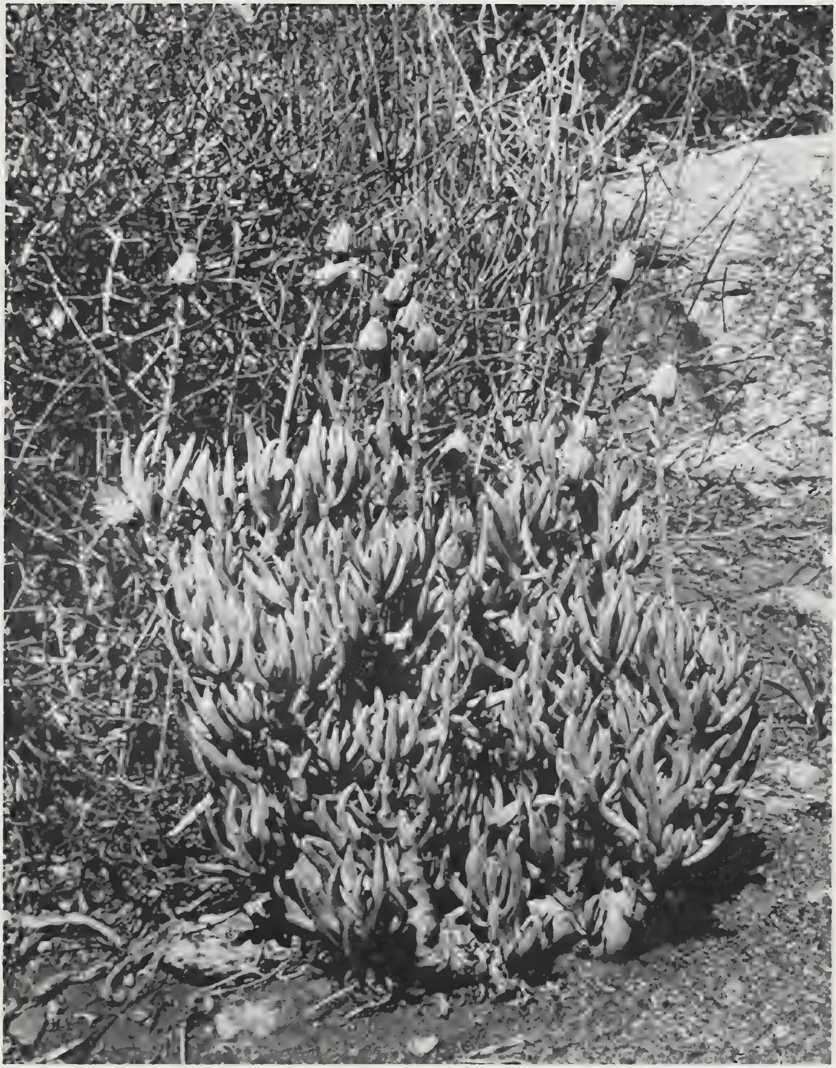


Plate XI. *Kleinia cephalophora*. Compton.

differs in the shorter, wider shape of the leaves, the shorter peduncles, the smaller capitula and the much smaller number of flowers in the capitulum: *M. imbricata* having about 200 florets in the capitulum, which is about 10 mm. long and 8—10 mm. in diameter.

Nestlera angusta Compton. (Compositae-Inuleae.)

Fruticulus rigidus, ramosus, erectus, viscidulus. *Caules* primo lanati, mox glabrescentes. *Folia* numerosa, patentia, erectantia, linearia. obtusa, infra puberula, supra dense albo-lanata, marginibus inflexis, *Capitula* in umbello terminale sessilia. *Involucri bracteae exteriores* paucae, coriaceae, glabrae, *interiores* scariosae. *Paleae* nullae. *Flosculi radii* 5—8, breviter ligulati, feminei, *disci* c. 10, hermaphroditi; omnes flavi. *Achaenia radii* dense, *disci* minus, sericea. *Pappus* tubulosus, scariosus, marginibus laciniatis.

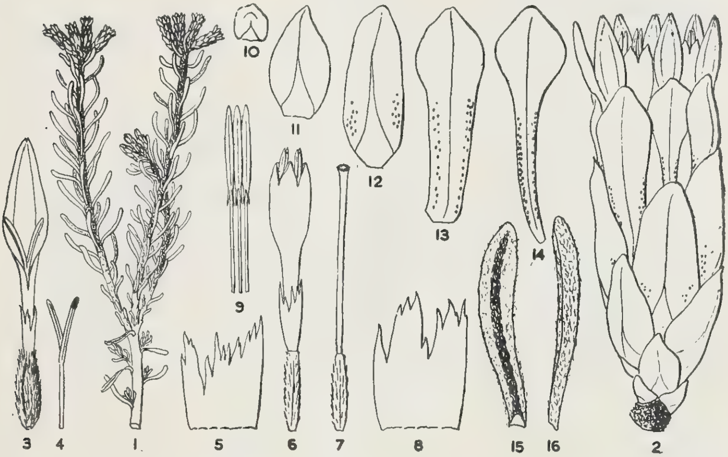


FIG. 3. *Nestlera angusta.* 1. Portion of plant, nat. size. 2. Capitulum × 8. 3. Ray floret × 8. 4. Style × 8. 5. Pappus × 16. 6. Disc floret × 8. 7. Gynaecium × 8. 8. Pappus × 16. 9. 3 stamens × 8. 10—14. Bracts × 8. 15. Leaf from above × 4. 16. Leaf, side view × 4. (*Compton* 18377.) *Del.* W. F. Barker.

Hab. Cape Province. Montagu Division: Eendracht, 4,000 ft. alt., 23 September, 1946, *Compton* 18377 (*Type*, in Herb. Nat. Bot. Gardens). Worcester Division: near De Doorns, September, 1907, *Bolus* 13130; Matjesfontein, September, 1922, *Thoday* in Herb. Bolus 17289.

A small erect rigid viscidulous shrub with numerous erect branches.

Stems slender, terete, white-lanate at first, soon glabrous. *Leaves* numerous, patent, mostly curved upwards, linear, obtuse, green viscidulous puberulous below, densely white-lanate above, the margins inflexed, c. 5mm. long, growing to c. 13 mm., 1 mm. broad. *Capitula* about 5 in a terminal sessile umbel. *Involucre* 5 mm. long, 2·5 mm. wide, the outer scales few, obtuse, coriaceous, glabrous, the inner scales scarious, erect or slightly spreading, slightly broadened near the tip. *Paleae* absent. *Ray florets* 5—8, shortly ligulate, female, corolla 4 mm. long, yellow, the stigmas slender, far-exserted. *Disc florets* c. 10, tubular, hermaphrodite, corolla yellow, 4 mm. long. *Ray achenes* densely silky-hairy, *disc achenes* more slender with few hairs. *Pappus* tubular, scarious with laciniate margins.

This species shows some resemblance to *N. corymbosa* Bolus which occurs in the same Western Karoo marginal region, but it differs in its more slender growth, narrower leaves, fewer, smaller and sessile capitula and in other characters.

I have not seen *N. tricephala* Harv. (Roodesand) or *N. tenuifolia* DC. (Zoutmelks R.), but judging from the meagre descriptions and the localities they can hardly be conspecific with this species.

Othonna intermedia Compton. (Compositae-Senecioneae.)

Radix tuberosa. *Folia* radicalia, ex pulvino lanato orientia, glabra, succulenta, spathulata, integra, obtusa. *Pedunculi* pauci, basales, plus minusve ramosi, parum folia excedentes. *Involucrum* late obconicum, bracteis 8—11, glabris, herbaceis, oblongis, acutis. *Flosculi radii* 8—12, feminei, ligulati, flavi; *disci* masculi, tubulosi, flavi. *Achaenia radii* pilosa, pappi setis copiosis; *disci* sterilia, pappi setis paucis.

Hab. Cape Province. Van Rhynsdorp Division: Knechts Vlakte, 25 July, 1941, *Compton* 11125, *Esterhuysen* 5295; 23 August, 1941, *Esterhuysen* 5669; 24 July, 1948, *Compton* 20686; 3 September, 1948, *Compton* 20873; 20 miles north of van Rhynsdorp, 18 July, 1948, *Compton* 20542 (*Type*, in Herb. Nat. Bot. Gardens); van Rhynsdorp, August, 1931, *Herre*, Stellenbosch Univ. Bot Garden 7747. Cultivated at Kirstenbosch, 843/48, where it flowered July, 1949.

Root tuberous, up to 2·5 cm. thick, tapering downwards, dark, resiniferous, constricted above and crowned at ground level with a densely white-woolly cushion from which the leaves and peduncles arise. *Leaves* radical, suberect, rather numerous, succulent, glabrous, narrowly to broadly spathulate or obcuneate, narrowing to a purplish base, flat, entire, obtuse, papery when dry, with about 5 diverging principal slender undulate veins and a fine network visible when dry; up to 7 cm. long and 4 cm. wide. *Peduncles* one or more arising from the cushion, more or

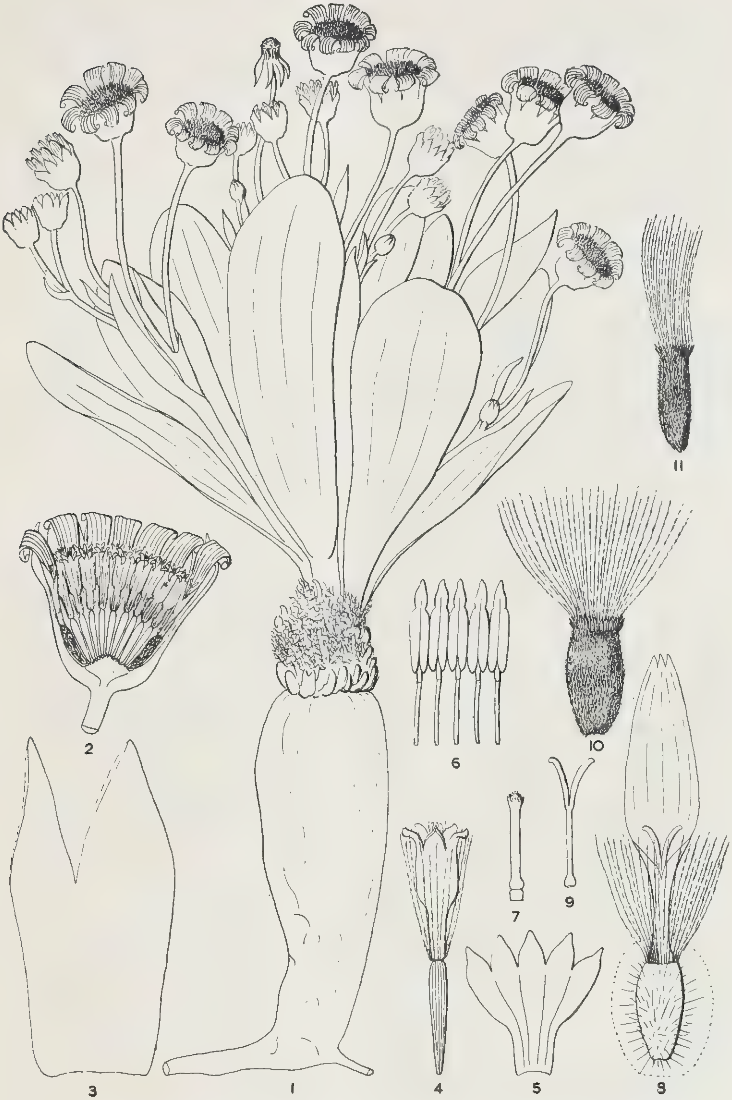


FIG. 4. *Othonna intermedia.* 1. Plant, nat. size. 2. Section of capitulum × 2½. 3. Bracts × 5. 4. Disc floret × 5. 5. Corolla, laid out × 10. 6. Stamens, laid out × 10. 7. Style × 5. 8. Ray floret, after boiling × 5. 9. Style × 5. 10. Achene, back view × 5. 11. Achene, side view × 5. (*Compton* 20542.) *Del.* W. F. Barker.

less branched, slightly exceeding the leaves, each fork having a large leaf-like bract in whose axil are a few woolly hairs. *Involucre* broadly obconical, 10—12 mm. long; bracts 8—11, herbaceous, glabrous, joined about half way, lobes oblong, faintly nerved, tapering to a long acute point. *Ray florets* 8—12, female, ligulate, corolla yellow, tube 3 mm. long, lamina 5 mm. long, obtuse, spreading. *Disc florets* functionally male, tubular, yellow, the lower part slender, 2 mm. long, the upper part urceolate, 2·5 mm. long. *Ray achenes* pilose, ovoid, the pappus copious, white, 3 mm. long. *Disc achenes* sterile, slender, the pappus scanty, 2 mm. long.

This deciduous herbaceous winter-flowering Othonna is fairly frequent in the white-quartz-strewn plains north of van Rhynsdorp, usually in the shelter of small shrubs. Its systematic position in the genus is somewhat obscure: the numerous basal leaves suggest the section Scapigerae, but the branching leafy peduncle would link it with the section Caulescentes. The numerous involucral bracts and ray florets (often more than 8) are unusual in the genus. The achene hairs (but not those of the pappus) swell and become mucilaginous when wet.

Selago wittebergensis Compton. (Selagineae.)

Fruticulus dense ramosus. *Rami* teretes, dense hirsuti. *Folia* numerosa, patentia, elliptica, in base angustata vel subpetiolata, obtusa utrinque et in marginibus hirsuta. *Flores* in spicis terminalibus densi. *Bracteae* liberae, subacutae, ovatae, foliaceae, supra glabrae, infra hirsutae, marginibus ciliatis. *Calyx* campanulatus, lobis tubo aequantibus, ovatis, obtusis, marginibus ciliatis, externe sparse hirsutis, tubo venis prominentibus. *Corolla* tubo incluso, lobis expansis, dorsalibus quadratis, emarginatis, lateralibus ventraleque obovatis, obtusis. *Stamina* 4, antheris omnibus exsertis.

Hab. Cape Province. Laingsburg Division: Witteberg, southern slope above Fisantekraal, 4,800 ft. alt., 7 November, 1948, *Compton* 21121 (*Type*, in Herb. Nat. Bot. Gardens).

A small woody densely branched shrub. *Stems* terete, densely hirsute. *Leaves* numerous, spreading, elliptical, narrowing to base or sub-petiolate, obtuse, hirsute on margins and both surfaces, multipunctate, the midrib scarcely prominent below, up to c. 6 mm. long, 2—3 mm. wide. *Flowers* numerous in dense spikes at end of branches. *Bracts* free, ovate, narrowing to base, sub-acute, concave, leaf-like, glabrous above, hirsute below, ciliate on margins, midrib not prominent, 3 mm. long, 2 mm. wide. *Calyx* campanulate, 2·2 mm. long, 1·5 mm. wide: tube with prominent veins: 5 lobes about equalling the tube, subequal in length, two rather broader than others, ovate, obtuse, ciliate on margins, sparsely hirsute outside, the hairs mostly reflexed. *Corolla* cream-coloured: tube included in calyx: lobes spreading, the dorsal quadrate, emarginate, 2 mm. long, 1·5 mm. wide, the lateral and ventral obovate, obtuse, 2 mm. long, 1 mm. wide. *Stamens* 4, all the anthers exserted.

Apparently allied to *S. ovatus* Rolfe, from the Hantam Mts., which however I have not seen, and which differs in many respects according to its description. On the Witteberg *S. wittebergensis* forms dense masses on the shady side of prominent rocks, no doubt frequented by animals: in these conditions it is densely loaded with leaves and flowers.

Gnidia insignis Compton. (Thymelaeaceae.)

Frutex ramosus, dense foliosus, glaber. *Folia* in genere magna, opposita, expansa, sessilia, basi cordata, late ovata vel orbiculata, textura tenuia, mucronata, marginibus integris, mesonevro apicem attingente. *Flores* multi in corymbis terminalibus densis, parum folia excedentes. *Calyx* dense hirsutus, striatus, segmentibus expansis, obtusis, flavis. *Squamae* 4, erectae, deltoideae, carnosae, fuscae, obtusae, marginibus inflexis. *Antherae* 8, biseriatae, inclusae, omnes fertiles. *Ovarium* dense hirsutum. *Stigma* capitellata.

Hab. Cape Province. Worcester Division: Molenaar's Berg, 1,500—3,000 ft. alt., 5 October, 1947, *Compton* 20114 (*Type*, in Herb. Nat. Bot. Gardens); same locality and date, south-east slopes above Du Toit's Kloof, 3,000—4,000 ft. alt., *Esterhuysen* 14060.

A much branched densely leafy shrub 50—75 cm. high, glabrous in all vegetative parts. *Leaves* opposite, spreading, sessile, cordate at base, broadly ovate or orbicular, thin in texture, mucronate, the margin entire, coriaceous, 25—35 mm. long, 20—40 mm. wide, the midrib slender, prominent below, extending to the apex. *Flowers* numerous, sessile in a dense terminal cluster surrounded by the uppermost leaves and just exceeding them. *Bracteoles* absent. *Calyx tube* c. 20 mm. long, slightly dilated at the base, gradually broadening in the upper half to 3 mm. diam., striate, densely hirsute; *segments* 4, spreading horizontally, 5 mm. long, 4 mm. wide, obtuse, hirsute below, glabrous above, pale yellow. *Scales* 4, erect, fleshy, dark-coloured, broad-based, deltoid, obtuse, the margins inflexed, 3 mm. long. *Anthers* 8 in two whorls, included, all fertile, 2 mm. long. *Ovary* 3 mm. long, densely hirsute. *Style* slender, 6 mm. long. *Stigma* capitellate.

This very striking Gnidia is clearly related to *G. orbiculata* C. H. Wright and to the widely distributed *G. oppositifolia* L., having the broad glabrous opposite leaves, the four dark fleshy "petals" with inrolled margins and the yellow hirsute calyx of those species. It is,

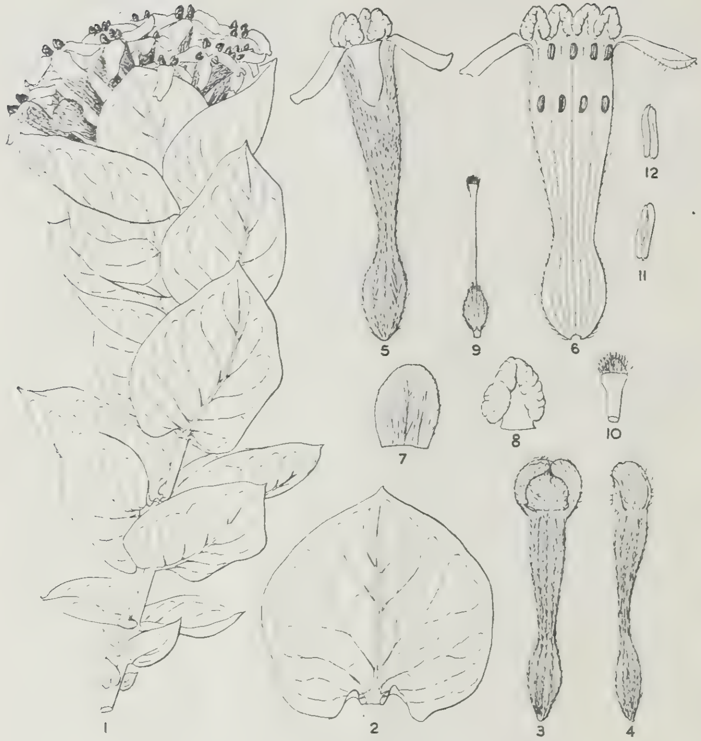


FIG. 5. *Gnidia insignis.* 1. Branch, nat. size. 2. Leaf, from above, nat. size. 3. Bud, front view × 2. 4. Bud, side view × 2. 5. Flower, side view × 2. 6. Calyx, laid out × 2. 7. Sepal, from beneath × 2. 8. Petal × 4. 9. Gynaecium × 2. 10. Stigma × 8. 11. Anther, back view × 4. Anther, front view × 4. (*Compton* 20114.) *Del.* W. F. Barker.

however, conspicuously distinct in its exceptionally large leaves and the large size of its flowers. It is so far only known on the southern slopes of the Molenaar's Berg above Du Toit's Kloof, where abundant material was collected by Miss E. Esterhuysen and myself on the same day during a country meet of the Mountain Club of South Africa.

GASTRODIA SESAMOIDES R. BR.

By W. F. Barker

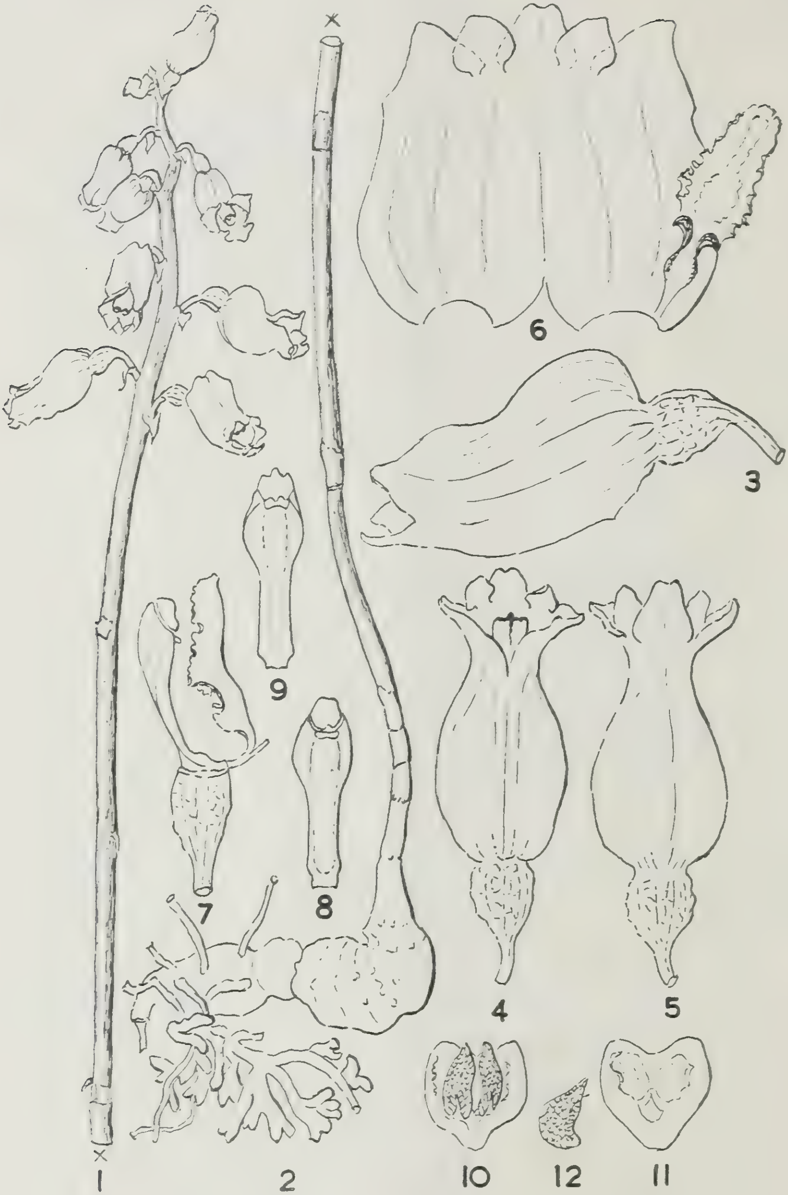
This interesting plant was first found growing at Kirstenbosch in uncultivated ground shaded by pine trees and other plants, in November, 1944. It was recognised as belonging to the family Orchidaceae, but the genus was doubtful, as its unusual structure did not compare with that of any known genus either in the Cape Peninsula or even in South Africa.

The brownish peduncles, which finally reached up to as much as three feet in height, emerged from the ground bearing small scale leaves at intervals along their length, but without any traces of radical leaves. They produced racemes of creamy brown pendulous flowers, with the perianth segments fused for the greater part to form a wide tube, the pendulous lip free within, and the labellum reminiscent of the genus Eulophia, but the pollen masses without glands.

The exact positions of the inflorescences were marked and the locality frequently observed for leaves, which, however, never appeared. When the underground portion of the plant was examined it was found to consist of a fleshy rhizome, and among the roots were groups of large irregular nodules similar to those occurring in saprophytic orchids found in other parts of the world, but hitherto unknown in South Africa: the nearest records being a species of Gastrodia and another of the related genus Auxopus, both being apparently leafless saprophytes, found in the Cameroons.

On further examination the plant was found to compare very well with the description of the genus Gastrodia, and it proved to be an exact match of the illustration of *Gastrodia sesamoides* R. Br. in J. D. Hooker's *Flora of Tasmania*, II, tab. 126, 1860. As this plant is a native of Australia and Tasmania and is known to occur only in this one locality in South Africa, it seems most probable that it has been introduced in comparatively recent times. It has not yet been possible to associate it with any particular type of humus, and it is the only saprophytic flowering plant known to occur in the Union of South Africa.

In 1949 as many as thirty racemes were seen in shaded undergrowth over a fairly large area. As the plant appears to have established itself and may even spread further afield, it has been thought desirable by the author of the section Orchidaceae in the forthcoming *Flora of the Cape Peninsula* to include it in the list of species in that area.



Gastrodia sesamoides. 1. and 2. Plant, nat. size. 3. Flower, side view × 3. 4. Flower, from above × 3. 5. Flower, from below × 3. 6. Perianth, opened out × 3. 7. Ovary and column with lip attached × 3. 8. Column with operculum, inner view × 3. 9. Column, with the operculum removed × 3. 10. Operculum with pollen masses, inner view × 6. 11. Operculum, with pollen masses removed, inner view × 6. 12. Pollen mass, side view × 6. (*Compton* 16571.) *Del.* W .F. Barker.

MORAEA ANGUSTA (THUNB.) KER AND ALLIED SPECIES

By G. Joyce Lewis

An examination of Thunberg's type of *Iris angusta* and of living material has shown that more than one species has been included under the name *Moraea angusta*, and that there has been some confusion here. This is scarcely surprising as there is little or no difference in the vegetative parts of these species, and the floral differences are very difficult, often impossible, to observe in dried material, unless it has been very carefully dried.

Thunberg's type, in good condition, together with his fairly detailed description, leave no doubt as to the identity of his species. The plant figured as *M. angusta* in the Botanical Magazine, t. 1276 (1810), a reproduction of Masson's figure (1775), is the same, as is also *M. obtusa* N.E. Br. The latter Dr. Brown distinguished from *M. angusta* by the smaller size of the plants and flowers and the colour of the flowers, the outer segments of which he described (from dried material) as lilac or violet. Fresh material of *M. angusta* collected on the slopes of Lion's Head (Thunberg's locality) and above Camps Bay showed some variation in the size of the plants and flowers, which were coloured as in *Botanical Magazine*, t. 1276. When dried, however, the flowers turned mauve or purplish, with white style crests. The type of *M. obtusa* has also been examined and there is no doubt that it is the same as *M. angusta.*

The following is a more detailed description of *M. angusta*, with synonymy and a list of the localities from which it has been recorded:—

Moraea angusta (Thunb.) Ker, Ann. Bot. 1, 240 (1805); Bot. Mag. t. 1276 (1810); *Iris angusta* Thunb., Diss. Iris, 28 (1782); *Moraea obtusa* N.E. Br., Kew Bull. 1931, 195.

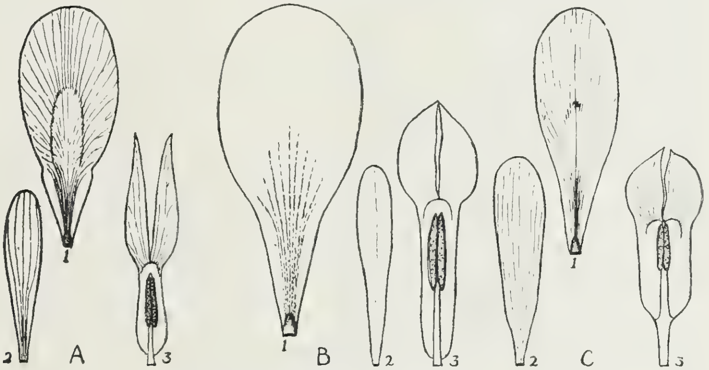
Corm 1·2—2 cm. diam.; tunics of numerous imbricating wiry brown fibres, occasionally extending up in a short neck. *Height* 15—50 cm., usually 25—30 cm.; stem simple. *Basal sheaths* 2, colourless, obtuse, 1—2·5 and 2·5—7 cm. long. *Leaves* 2 or rarely 3, the lowest arising 4—22 cm. above the base of the stem, sheathing for 1·5—4 cm., the blade firm, terete, semi-erect, 15—50 cm. long, usually 25—40 cm.; upper leaf (rarely 2) entirely sheathing, obtuse or sometimes acute, 2·5—4 cm. long, rarely with a small viscid patch below the node. *Inflorescence* solitary, terminal, 4—6-flowered, rarely with a small viscid patch below the spathes. *Spathes* firm, green, usually red-tipped, obtuse or truncate, the inner 5—7·5 cm. long, twice as long as the outer. Flowers dull yellow, the outer segments with a bright yellow patch above the claw, the outer surface pale brown veined with purple. *Outer perianth segments* 3—5 cm. long, the blade nearly twice as long as the claw, obtuse, 1—1·8 cm. wide; *inner segments* 2—3 cm. long, obtuse, 3—5 mm. wide. *Filaments* 5—7 mm. long (sometimes up to 1 cm.), united for 1—3 mm.; *anthers* 0.7—1 cm. long; *pollen* orange-red. *Style* about 1 mm. long, with branches 1·2—1·5 cm. long, 3 mm. wide; *crests* 1·4—2·2 cm. long, obliquely acute or acuminate, 3—5 mm. wide. *Capsules* oblong, 1·5—2 cm. long.

Hab. Cape Province. Cape Peninsula: on hills below Devil's Peak and Lion's Head, *Thunberg* (*type,* Uppsala); western slopes of Lion's Head, *Lewis,* S.A.M. 59717 (S.A.M.); Devil's Peak, *Elliott* 1095 (K.); near Camps Bay Toll, *Dod* 1358 (K., B.H.); lower mountain slopes above Camps Bay, *Lewis,* S.A.M. 57106 (S.A.M.); slopes between Constantia Nek and Hout Bay, *Dod* 3268 (B.H., K., B.M.); Bishops Court, near Kirstenbosch, *Barker* 4790 (N.B.G.); slopes of Table Mt., above Zonnebloem, *Zeyher* 46 (S.A.M.); marshy plateau on Muizenberg Mt., 1,400 ft., *Salter* 8563 (S.A.M.); Silvermine Valley, *Salter* 327/9 (B.M.); Bergvliet, *Purcell,* S.A.M. 59719 (S.A.M.); Simons Bay, *Wright* 271 (K.). Cape Division: marsh at Crawford, *Weintroub* in Herb. Moss 18185 (K., B.M.) (type of *M. obtusa* N.E.Br.). Stellenbosch Division: slopes of Triplets, Somerset West, *Esterhuysen* 8239 (B.H.). Caledon Division: top of Sir Lowrys Pass, *L. Bolus,* B.H. 20319 (B.H., K.); Buffels River Valley, near Hangklip, *Barker* 1323 (N.B.G.). Paarl Division: French Hoek, *Barker* 4123 (N.B.G.); top of French Hoek Pass, *Salter* 4943 (K., B.H., B.M.); French Hoek Peak, *Stokoe,* S.A.M. 58742 (S.A.M.); French Hoek, mountain top north of Kriel's Farm, 2,300 ft., *Phillips* 1302 (S.A.M.); Paarl, *Zeyher* 4077 (S.A.M.). Malmesbury Division: Mamre Road, 23 miles from Cape Town, *Barker* 4096 (N.B.G.). Piquetberg Division: Gruys Kop, Piquetberg, *Pillans* 7399 and 7614 (B.H.). Knysna Division: banks of Knysna River, above bridge, *Galpin* 4642 (K.).

Flowering season August—November.

Living material of the species described below as *M. neglecta* can readily be distinguished from *M. angusta* by the difference in the colour and texture of the flowers, those of *M. neglecta* being firmer, not very delicate and almost translucent as in *M. angusta,* in which the conspicuous purple veins on the under side of the segments are visible also on the upper side. *M. neglecta* has bright yellow (occasionally cream-coloured) flowers, the outer segments with fine black dotted lines on the upper surface on the claw and lower part of the blade. The claw of the outer segments, in comparison with the blade, is longer in this species and the style branches are longer, with comparatively shorter and broader crests. These differences can be seen in the accompanying figures. In *M. angusta* the pollen grains are orange-red, whereas in *M. neglecta* they are almost always pale yellow or whitish. Out of more than 50 specimens examined in the field, only 2 were found with pale orange grains.

In almost all the plants of *M. neglecta* examined, there is a small viscid ring on the stem just below the spathes. As this occasionally occurs in *M. angusta*, also rarely below the short sheathing leaf or leaves, no great importance can be attached to this character. On the whole *M. neglecta* is a more robust species than *M. angusta*, with larger flowers.



A. *Moraea angusta* (Thunb.) Ker. B. *M. neglecta* Lewis. C. *M. anomala* Lewis
1. Outer perianth segment. 2. Inner perianth segment. 3. Style branch and stamen.

About the validity of the species described below as *M. anomala* there is a slight doubt as sufficient living material has not been examined. In colouring and texture the flowers are like those of *M. angusta* and it is possible that these species are more closely connected than they appear to be from the material so far examined. *M. anomala* is distinguished from *M. angusta* and *M. neglecta* by the larger size of the inner perianth segments, compared with the outer, and by the fact, also noted by Miss W. F. Barker, that the filaments are united for at least half their length, and the style branches connate into a column at the base. The free part of the style branches is comparatively broader, as are also the crests which are similar to those of *M. neglecta*. The pollen grains are orange-red and there is a minute apiculus above the anther cells, also present in *M. angusta* but not in *M. neglecta.* In material of *M. anomala* examined there are almost always 2 short acute sheathing leaves (rarely obtuse or subobtuse), and there is seldom a viscid patch below the inflorescence, but, as mentioned above, these characters cannot be relied on to distinguish the species as they are not constant.

Moraea neglecta Lewis sp. nov.

Cormus, caulis, folia, spatha et inflorescentia *M. angustae* similes, sed fere sub spathis parvo annulo viscoso ornata. *Planta* 20—50 cm. alta, fere 30—40 cm. *Folia* 2; inferius teres, 22—70 cm. longum; superius vaginans, obtusum, 2—4·5 cm. longum. *Spathae* interiora 5·5—7 cm. longa, quam exteriora bis longiora. *Flores* flavi vel pallide flavi, segmentorum exteriorum unguibus et laminarum partibus inferioribus nigro-striatis; *segmenta exteriora* 4—5 cm. longa, lamina obovata, 2—2·5 cm. longa, 1·5—2 cm. lata; *interiora* 2·5—3 cm. longa, obtusa, 4—5 mm. lata. *Filamenta* 0·8—1·2 cm. longa, basi per 1 mm. conjuncta. *Stylus* 1 mm. longus, ramis 1·8—2·4 cm. longis, 4—5 mm. latis; cristae 1·5—1·8 cm. longae, 5—7 mm. latae.

Hab. Cape Province. Cape Peninsula: flats near Rondebosch, *Bolus* 3802 (B.H., K., B.M.); flats at Rondebosch, *Dod* 598 (B.H., K., B.M.); Bergvliet, *Purcell*, S.A.M. 59719 (S.A.M.); eastern slopes of Table Mt., *MacOwan* 1966 (K., S.A.M.); Cape Town, *Elliott* 1198 (K.); between Skeleton and Window Gorges, *Leighton* 1516 (B.H.); Muizenberg Mt., *Salter* 6275 (K.); Kommetje, *Barker* 5886 (N.B.G.); Redhill, *Compton* 13787 (N.B.G.); near Klaasjagers, *Barker* 5903 (N.B.G.); Smitswinkel, *Barker* 797 (N.B.G.); upper Klaasjager Valley, *Salter* 7710 (S.A.M.); near Sirkels Vlei, *Lewis*, S.A.M. 57107 (*type*, S.A.M.); Smith's Farm, near Cape Point, *Barker* 81 (K.). Malmesbury Division: Hercules Pillar, *Barker* 1816 (N.B.G.); *Leighton* 643 (B.H.); Bok Point, *Kies* 170 (N.B.G.); Mamre Hills, *Compton* 17436 (N.B.G.). Tulbagh Division: Saron, *Schlechter* 10659 (K., B.M.). Piquetberg Division: Piquetberg, *Leighton* 66 (B.H.); Eendekuil, *Howes* 192 (K.); Het Kruis, *Stephens* 8602 (K.). Clanwilliam Division: between Warm Baths and Modderfontein, *Stephens* 7077 (B.H., K., B.M.); Pakhuis Pass, *Salter* 1661 (K.); *Leipoldt* (B.H.). Ceres Division: Elands Kloof, *Barker* 3123 (N.B.G.).

Flowering season September to December, usually September to October.

Corm, stem, leaves and inflorescence as in *M. angusta,* but nearly always with a small viscid ring below the spathes. *Height* 20—50 cm., usually 25—35 cm. *Lowest leaf* 22—70 cm. long, usually 30—40 cm. *Spathes* as in *M. angusta,* the inner 5·5—7 cm. long, twice as long as the outer. *Flowers* yellow or occasionally cream-coloured, the outer segments streaked with fine black lines on the claw and lower half of the blade. *Outer perianth segments* 4—5 cm. long, the blade obovate, 2—2·5 cm. long, 1·5—2 cm. wide; *inner segments* 2·5—3 cm. long, obtuse, 4—5 mm. wide near the top. *Filaments* 0·8—1·2 cm. long, united for 1 mm.; *anthers* 1 cm. long; *pollen* yellow, cream-coloured or white, very rarely orange. *Style* 1 mm. long; branches 1·8—2·4 cm. long, 4—5 mm. wide; crests 1·5—1·8 cm. long, 5—7 mm. wide. *Capsules* oblong, 2·2—2·5 cm. long.

Moraea anomala Lewis sp. nov.

Cormus, caulis, folia et inflorescentia *M. angustae* similes, sed fere foliis 2 brevibus vaginantibus acutis. *Planta* 30—45 cm. alta. *Folium infimum* teres, 20—55 cm. longum; 2 *superiores* 3—5 cm. longa. *Spathae* virides marginibus rubris, multo-striatae, obtusae vel subacutae, exteriora 2·8—3·8 cm. longa, interiora 4—6 cm. longa. Color florum *M. angustae* simillimus; *segmenta exteriora* 3·6—4 cm. longa, lamina obtusa, 2—2·3 cm. longa, 1·1—1·5 cm. lata; *interiora* 3·1—3·3 cm. longa, obtusa, c. 8 mm. lata. *Filamenta* 1·5—1·7 cm. longa, per 0·8—1 cm. conjuncta. *Stylus* 0·8—1 cm. longus, ramis 1·1—1·3 cm. longis, 7—8 mm. latis; cristae 1—1·2 cm. longae, 5—6 mm. latae.

Hab. Cape Province. Caledon Division: Houw Hoek Pass, *Lewis*, S.A.M. 58100 (*type*, S.A.M.); Amandel Rivier Vlei, *Barker* 310 (N.B.G.); Caledon, *Schlechter* 5528 (B.H.); near Hermanus, *Bolus* 9685 (B.H.). Robertson Division: Boesman's Kloof Pass at McGregor, *Leipoldt* 3558 (B.H.). Clanwilliam Division: Elands Kloof, *Lewis*, B.H. 24394 (B.H.); between Groot Rivier and Elands Kloof, *Leipoldt* 3009 (B.H.). Ceres Division: Gydouw, *Leipoldt* 3008 (B.H.).

Flowering season October to November.

Corm, stem, leaves and inflorescence as in *M. angusta*, but almost always with 2 short acute sheathing leaves. *Height* 30—45 cm.; stem rarely with a viscid ring below the spathes. *Lowest leaf* 20—55 cm. long; *upper leaves* 3—5 cm. long. *Spathes* firm, green, red-margined, closely many-veined, obtuse or subacute, the outer 2·8—3·8 cm. long, the inner 4—6 cm. long. *Flowers* coloured as in *M. angusta*. *Outer perianth segments* 3·6—4 cm. long, the blade slightly longer than the claw, obtuse, 1·2—1·6 cm. wide; *inner segments* similar but slightly smaller, 3·1—3·3 cm. long, about 8 mm. wide. *Filaments* 1·5—1·7 cm. long, united for 0·8—1 cm.; *anthers* about 7 mm. long; *pollen* orange-red. *Style* 0·8—1 cm. long; branches 1·1—1·3 cm. long, 7—8 mm. wide; crests 1—1·2 cm. long, 5—6 mm. wide.

Abbreviations: B.H.=Bolus Herbarium; B.M.=British Museum; K.=Kew; N.B.G.=National Botanic Gardens Herbarium, Kirstenbosch; S.A.M.=South African Museum.

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AANTEKENINGE OOR DIE VOORTPLANTING EN BRANDPERIODES VAN PROTEA MELLIFERA THUNB.

(With a Summary in English)

deur P. G. JORDAAN

INLEIDING

Die studie van die voortplanting van 'n groep sluit onder meer in 'n studie van die bou en ontwikkeling van die voortplantingsorgane, van die blomtye, bestuiwing, bevrugting, onvrugbaarheid, saadverspreiding, ontkieming, lewensloop, lewensduurte, spruitvermoë, vegetatiewe voortplanting en die invloed van fisiese en biotiese faktore op die voortplanting. Afgesien van die kenmerke van die voortplantingsorgane van die Proteaceae wat in sistematiese werke behandel is, is ander aspekte van die voortplanting van enkele Suid-Afrikaanse soorte van die familie ondersoek deur Ballantine (1909), Phillips (1927), de Vos (1943), Thorns (1943), Jordaan [1944, 1945 (*a*), 1945 (*b*), 1946] en Garside (1946). Aangesien die familie so 'n belangrike rol speel in die plantegroei van die Winterreënstreek van Suid-Afrika, kom verwysings na die voortplanting van die groep of van bepaalde soorte dikwels voor in literatuur oor die fitogeografie, beheer en beskerming van die plantegroei in die genoemde streek.

Die meeste van die waarnemings waarop hierdie artikel gebaseer is, is reeds voor 1944 ingesamel om die lewensloop van 'n aantal soorte van die Proteaceae wat embriologies ondersoek is, te bepaal. Die skrywer kon sedertdien nie die geleenthede vind om die waarnemings deur verdere veldstudie aan te vul en om gevolgtrekkings wat daarvan afgelei kan word, deur waarnemings in die veld te kontroleer of eksperimenteel te toets nie. Hoewel die waarnemings onvolledig is, kan daarvan afleidings gemaak word wat moontlik lig werp op die aktuele probleem van veldbrande.

LEWENSLOOP.

Die knoppe van die bloeiwyse is vanaf Januarie sigbaar; hoewel die meeste blomme vanaf Maart tot Junie (veral in April) oop is, is oop blomme ook al waargeneem gedurende Februarie, Julie, Augustus, September en selfs in Oktober. Die kiem ontwikkel stadig en eers sewe maande nadat die blom oop was, d.w.s. gewoonlik omstreeks November, het die embrio sy volwasse grootte bereik. 'n Jaar na die blomtyd, d.w.s. omstreeks April, is die vrugte droog en volwasse. Tien tot twintig persent van die vrugbeginsels in die bloeiwyse vorm normale vrugte. Talryke vrugbeginsels vorm dowwe vrugte wat uitwendig presies soos die normale vrugte lyk maar wat sonder embrios is. Tot 80 persent van die skynbaar normale vrugte is dof.

Die bloeiwyses gaan oop net voordat die blomme begin ontluik en bly vir tien tot veertien dae oop. Twee maande na 'n bloeiwyse begin oopgaan het, is dit weer styf toe en is die omwindselblare wat voorheen heldergekleurd was, swartbruin. Nadat die vrugte ryp is, vou die droë omwindselblare oop en kan die vrugte wat teen die tyd los van die blommebodem is, versprei. Hoewel die meeste van die bloeiwyses gedurende April oopgaan en die vrugte dan onmiddellik kan versprei, bly van die vrugte tot twaalf maande nadat die droë bloeiwyse oopgegaan het, op die blommebodem lê en kan selfs in hierdie posisie ontkiem. Bloeiwyses gaan ook onder die invloed van hitte en vuur oop.

In die natuur ontkiem die vrugte gedurende die reënseisoen. Vrugte wat in Maart gesaai is, het goed ontkiem en na veertien dae was die kiemblare bo die grond. Rondom plante wat gedurende Januarie tot Maart doodbrand, is later altyd weer 'n aantal jong plante gevind. *P. mellifera* plant nie vegetatief voort nie en vorm ook geen spruite na 'n brand nie.

Bespreking.

'n Paar belangrike vrae oor die lewensloop van *P. mellifera* is nog onbeantwoord. (i) Wat is die kiemkragtigheid van die vrugte vanaf die stadium wat die kiem volwasse is totdat die droë bloeiwyses normaal oopgaan? Gedurende hierdie periode geskied die meeste veldbrande. (ii) Wanneer ontkiem die sade wat in die verskillende tye van die jaar versprei word? (iii) Hoe oud is 'n plant voordat dit vir die eerstemaal blomme vorm? Wat (i) betref is jong plante waargeneem rondom plante wat gedurende Januarie tot Maart dood gebrand het, maar dit is nie bepaal of die plante ontwikkel het uit vrugte van die laaste of voorlaaste blomtyd nie. Morfologies is die vrugte volwasse en dit kan aangeneem word dat hulle kiemkragtig is na 'n veldbrand wat die natuurlike uitdroging wat die sade nog moet ondergaan, verhaas. Aangaande (ii) is dit veral van belang om te weet of die vrugte wat in die middel en teen die einde van die reënseisoen en gedurende die somer versprei, kiemkragtig is, of hulle onmiddelik na verspreiding ontkiem en of hulle eers by die begin van die volgende reënseisoen ontkiem. Wat (iii) betref is uit toevallige waarnemings afgelei dat die periode wat verloop vanaf ontkieming totdat die eerste vrugte gevorm word, d.w.s. die *jeugperiode*, omstreeks ag jaar is (m.a.w. sewe jaar totdat die soort vir die eerste keer blom).

Die periode vandat die knoppe van die bloeiwyse sigbaar is tot op die stadium wat die meeste blomme oop is, is ongeveer vier maande. Hierdie tydperk is die *blomvormingsperiode* van die soort.

Die meeste blomme van die soort is oop van Maart tot Junie. Blomme wat voor Maart en na Junie oop is, kan as toevallig beskou word. Die *blomperiode* van die soort strek dus van Maart tot Junie, met die maksimale blomtyd in April.

Die embrio's neem sewe maande om hul volwasse grootte te bereik. Die *vormingsperiode van die kiem* van die soort strek dus van Maart (die begin van die blomperiode) totdat die embrio's in die blomme wat gedurende Junie oop was, volwasse is, d.w.s. tot Februarie. Omdat die maksimale blomtyd in April is, is die meeste embrio's in November volwasse.

'n Belangrike periode in die lewensloop van 'n soort is die tydperk met kiemkragtige vrugte (*vrugperiode*). Normalerwys is die vrugte vanaf April volwasse, maar dit is reeds aangetoon dat 'n veldbrand waarskynlik die rypwording van die vrugte aanhelp sodat t.o.v. van veldbrande Januariemaand as die begin van die vrugperiode beskou kan word. Na Junie is op die plante soms nog ou geslote bloeiwyses (wat dikwels deur insekte beskadig is) en soms ook nog vrugte wat los op die blommebodem lê. Die vrugte wat na Junie op die plante voorkom, vorm 'n geringe persentasie van die hoeveelheid vrugte wat deur 'n plant gevorm word. Afgesien van wat die ontkiemingsvermoë en ontkiemingstyd van hierdie vrugte is, is hulle buite rekening gelaat omdat hulle as toevallig beskou word. Junie word dus beskou as die einde van die vrugperiode.

Dis onbekend wanneer presies vrugte in die natuur ontkiem. Aangesien vrugte wat in Maart gesaai is, spoedig ontkiem het, kan aangeneem word dat in die begin van die reënseisoen die vrugte onmiddelik nadat hul versprei is (d.w.s. veral vanaf April), sal ontkiem. Thorns (1943) sê dat geen sade van Proteaceae wat na Julie gesaai is, ontkiem het nie, maar dit is onseker of toetse ook met *P. mellifera* gemaak is. As dit ook vir *P. mellifera* waar is, sal die vrugte tot Junie begin ontkiem namate hul versprei, terwyl dié wat na Junie versprei word, nie teen die end van die reënseisoen sal ontkiem nie. Volgens Thorns neem dit 5—8 weke vir die sade van Protea soorte om te ontkiem. As dit ook vir *P. mellifera* waar is, sal die sade wat in Junie versprei word, nog in Augustus besig wees om te ontkiem. Die periode waarin ontkiemende sade in die natuur voorkom (*ontkiemingsperiode*) strek dus van April tot Augustus.

In die lewensloop van *P. mellifera* kan gevolglik die volgende agtereenvolgende periodes onderskei word:—die blomvormingsperiode, blomperiode, vormingsperiode van die kiem, vrugperiode, ontkiemingsperiode en die jeugperiode.

Hierdie agtereenvolgende periodes (wat betrekking het op die soort as geheel of op 'n gemeenskap van hierdie plante) oorvleuel mekaar sodat normalerwys op 'n bepaalde tydstip meer as een periode van die soort gevind word.

BRANDPERIODES

Uit die gegewens oor die lewensloop kan die voortplantingstoestande van die soort vir elke maand van die jaar bepaal word en kan die invloed van vuur in die afsonderlike maande afgelei word.

Die enigste periode waarin die soort 'n vuur kan weerstaan, is die vrugperiode, d.w.s. van Januarie tot Junie. Omdat die vrugte so lank na die blomtyd eers ryp is, val die blomvormingsperiode en die blomperiode binne die vrugperiode. Die grootste gedeelte van die ontkiemingsperiode val saam met die vrugperiode en die vormingsperiode van die kiem begin in die vrugperiode. (Die jeugperiode wat oor 'n aantal jare strek, kan voorlopig buite rekening gelaat word.) Dit kan dus nie verhoed word nie dat 'n veldbrand op enige tydstip in die vrugperiode sommige van die voortplantingstadia verniel.

Die maksimale ontkiemingstyd is in April sodat die meeste vrugte op hierdie tydstip reeds besig is om te ontkiem. 'n Veldbrand vanaf April tot Junie sal gevolglik ongunstig wees omdat dit so 'n groot hoeveelheid ontkiemende sade en saailinge sal verniel.

'n Veldbrand van Julie tot Desember sal die embrio's wat besig is om in die blomme van die jongste blomtyd te ontwikkel, verniel. So 'n brand sal ook die ontkiemende sade en saailinge doodbrand, m.a.w. 'n brand van Julie tot Desember kan al die periodes be-eindig.

Die gevolgtrekking is dat, ten opsigte van geslagtelike voortplanting, Januarie tot Maart 'n *veilige,* April tot Junie 'n *ongunstige* en van Julie tot Desember 'n *gevaarlike brandperiode* vir *P. mellifera* is.

Die periode wat moet verloop tussen twee agtereenvolgende veilige brande, d.w.s. die *brandpouse,* word bepaal deur die lengte van die jeugperiode. Aangesien dit omstreeks ag jaar neem vanaf ontkieming totdat die eerste kiemkragtige vrugte gevorm word, is die minimum brandpouse van *P. mellifera* ook omstreeks ag jaar. 'n Veldbrand wat binne die brandpouse van die soort ontstaan, kan die algehele uitsterwing van die nageslag van die oorspronklike plante veroorsaak.

As die brandperiodes en brandpouse van *P. mellifera* deur bogenoemde periodes in die lewensloop bepaal word, is dit redelik om te verwag dat dit ook die geval sal wees met ander plantesoorte. Kennis van die verskillende periodes van elke soort sal dus nodig wees om te bepaal wanneer elkeen gebrand kan word sonder gevaar van uitroeiing of drastiese vermindering in die area.

SUMMARY

1. The life cycle of *P. mellifera* is described and discussed.

2. Different periods are evident in the life cycle of the species viz. a period of floral development, a flowering period, developmental period of the embryo, the fruiting period, germination period and youth period.

3. These periods overlap so that at any time during the year more than one period are to be found.

4. From the data it is inferred that, as far as sexual reproduction is concerned, January to March is a safe, from April to June an unfavourable and from July to December an unsafe fire period for the species.

5. The interval between successive safe fires is determined by the youth period and is about eight years for *P. mellifera*.

6. If there is a safe and unsafe fire period and a definite fire frequency for *P. mellifera*, it is to be expected that the same will be true for other species of plants.

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